THE
ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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THE PACIFIC CABLE.

IN its issue of the 15th inst., under the heading of "A Costly Fad," the *Daily Graphic* makes a boast of being "One of the few organs of public opinion that ventured to protest against wasting the taxpayers' money upon a popular delusion," and complains of the contributions by the various countries concerned towards the deficit of £72,556; apparently, however, it has not taken into consideration the probable amount of saving to each contributor by reason of the reduction of rates and increased facilities. Would Australian cable rates have been reduced if the Pacific Cable had not been laid, and did one of the owners of the cable—the Commonwealth—support it when it started business? It must be known to our contemporary that a favourable opportunity to compete was given to the Eastern Telegraph Co. It is our opinion that, from a financial point of view, the cable has been a gain to the Empire. Again, our contemporary says, "An all-British cable presents no special advantages in time of peace." Will it say why Germany, Holland, France and the United States are laying national cables to their colonies if this be a fact? Further, it says that in time of war the cable is more exposed to attack because it is not protected by the rule of international law; that a cable landed on neutral territory is neutral for the whole of its length except to the last 3 miles where it joins the enemy's territory; but it is common sense to think that a nation owning property, whether under the sea or not, will take measures to protect it. The whole secret of the usefulness of British lines was that they could and would be defended more thoroughly if they were under State control, whereas under private control they might possibly be left to take their chance. An enemy will cut cables whether neutral or not, if he can, when its existence is prejudicial to his interests, and the damage will be paid for. The positions of the Pacific Cable would have to be ascertained before the wholesale cutting the *Daily Graphic* foresees takes place, and even if the positions be known, how will any but a suitably equipped cable steamer succeed in grappling the cable in the depths of the Pacific?

From a commercial point of view there is no doubt that it would have been better to lay the cable *viâ* Honolulu, but supposing, with the existing strong feeling towards our own Colonies, we were to institute Tariff Reform, what would Honolulu or the States gain by allowing a British cable to land? Would they retaliate by charging a prohibitive tax on all British messages? Of what use would the cable be then? We cannot imagine the *Daily Graphic* to be serious when it tries to affirm that the Pacific Cable would have earned £70,000 a year more by landing at Honolulu. It might have made a few thousands of pounds difference, say, perhaps, £10,000 a year.

The cable might advantageously have been landed at

Neckar Island, and a spur line taken on to Honolulu after that island had been made British, but why was not a line taken from Fanning to Honolulu, and thence to China and Japan? It has been taken on since from San Francisco. Such questions as these may give the writer of "A Costly Fad" something to think about, and he will not be so proud of being British.

A little of the American enterprise might have saved the situation and kept the British route *viâ* Honolulu intact, as those who advocated it intended it to be.

It is a pity that matters of this nature should be discussed before a proper study from all sides is made, as the result can only be mistaken and injurious criticism.

Electrolysis in America.

If we are to judge from the experiences made public from time to time in the American technical papers, and from many articles which have dealt with the manifestations and cure of electrolysis arising from tramway stray currents, the position of the pipe owner in that country is not enviable. There is a legal remedy as in England, but no one knowing the difficulties in the way of proving that the destruction of pipes has been brought about by the action of stray currents belonging to some particular person would willingly, or without taking much thought, go into Court with a case.

Impelled by we do not know what external force, many of the larger tramway concerns have made efforts to minimise or to remove the reproach which justly and unjustly has been set up against them, and *Cassier's Magazine* contains an article by Mr. A. A. Knudson which reviews in brief the leading methods which have been tried.

The problem is to make the tramway retain its return currents along its whole length, and the one obviously perfect way to do this is to give up the rails and to use a second insulated wire over each track as a return conductor, re-inforcing this when necessary by feeders in the present fashion.

Like most counsels of perfection, that one is not likely to have any extended advocacy in practice, for it is said that in one at least of the very few instances of double-trolley working, the rails have known more about return currents than the authorities who imposed the system would like to hear.

The next lower step towards the protection of outside interests is to lay 60 ft. rails and weld them into a continuous length. Auxiliary feeders are used to help the rails when the necessity arises. Even so, the near presence of a good-sized water or gas main, or of a lead-sheathed cable, may prove an irresistibly attractive path for part of the tramway current, and actually the lines which are laid in this way are not much more numerous than those with a double trolley, although the tendency is for the number to increase.

The ordinary tramway in the States, and perhaps elsewhere, has bonded joints, which may not be in too good repair, unassisted by anything except neighbourly pipes for carrying the return current.

With the idea of preventing damage to these pipes, either they have been enlisted frankly in the tramway service by bonding them to the rails near the power house or to special cables straight to the negative bars, or their Samaritan instincts have been checked by insulating their joints.

The first scheme would be excellent if the pipes themselves were electrically continuous, but too often considerable resistance is offered by the joints. The bonding may have made the pipes more attractive than before, and the pitting trouble then will be accentuated in that pipe line, and may even widen the danger area by inducing other pipes to take part in the distribution of the return current.

The more one bonds the more one has to bond if all damage is to be avoided. Insulated joints at a few particularly dangerous places are effective sometimes, but the cost of doing the thing thoroughly is prohibitive. Insulating the whole pipe has been tried in a few cases, but with no success.

The negative booster, which is to be seen protecting all the heavily loaded routes of the United Kingdom, is hardly known in the States, for (Mr Knudson naively remarks) this plan necessitates a continual operation of the (booster) dynamo, and is more or less an annoyance to a railway company. After all, then, "the company" in America is no more naturally inclined to self-sacrifice than it is in England, and nothing but pressure by the Board of Trade would have induced our engineers to complicate their power stations further.

We cannot find any excuse for Mr. Knudson's use of "calk" for caulk. It is nearly enough national to find a place in the famous Roosevelt 300, but the redundant letter in the English word, if there is any, is l, not u.

The Imaginary Motor-'Bus.

Mr. Chas. Bright is concerned about the motor-'bus. For some years he has asked the public why they have anything to do with tramcars, when within the next century at least a perfect motor-vehicle will be ready to take them anywhere for nothing or less.

Imagine people wanting tramways in Piccadilly! he says in a letter to the *Outlook* (September 7th). Soon London will be as bad as New York, where everyone travels by tramway because nothing else is possible. Yet we do not hear the New Yorkers complaining of the absence of motor-'buses from their principal streets. Perhaps they don't understand.

Mr. Bright convinces the readers of the *Outlook* that at present the motor-'bus is hardly worth consideration as an economic rival of the tramcar, as the cost of running is nearly double, and until road surfaces are made so smooth that the necessary tractive effort is no greater than that required for a tramcar running on steel rails, terms of commercial equality cannot be obtained.

We cannot say that Mr. Bright puts his case in the most sanguine light, and he would have done better to have left the matter after reproducing the old story about the flexibility of the motor, that remarkable quality which is sure to kill the tramcar entirely one of these days, if it does not miss the mark.

Mr. Bright looks sufficiently far ahead in order to catch a glimpse of the perfect motor-'bus, but he is so much occupied in watching it shooting like a meteor along a perfect road that he misses the perfect tramcar running just ahead on an ideal track—sans joints, sans corrugations, sans dirt, sans everything; otherwise he might not say, " . . . in days to come we shall travel much faster; and, that being so, the tramway is bound to be voted a nuisance on many roads, if only on account of the constant tramway blocks preventing independent vehicles from attaining a speed approximately near to what could otherwise be attained"; and again, "Are we not more likely to approach the ideal of satisfactory locomotion at a high speed . . . . by means of a perfected motor-'bus service than we ever could with a tramcar system?"

Observe that the motor-'bus is amongst the angels, while the tramcar seems to be forbidden the gate.

From the power station to the permanent way and the cars there is nothing perfect about a tramway system, but the motor-'bus is younger and less developed still, and both will continue to improve, and to work together, or in opposition, for the benefit of mankind for a longer time than Mr. Bright or we can see ahead.

POWER TRANSMISSION LINES.

By T. L. KOLKIN.

(*Concluded from page* 417.)

By applying the above values of $\frac{w - l_0}{l_0}$ to our formula—

$$t = \frac{1}{\alpha}\left(\frac{w - l_0}{l_0}\right) - \frac{\sigma}{\Sigma} + \left(\frac{p^2 w^2}{24\ \sigma^2 s^2}\right),$$

we arrive at Tables V and VI.

TABLE V.—Copper.

σ	t at s = 20.	t at s = 40.	t at s = 80.
	w = 30 m.		
6	− 20·3° C.	− 14·0° C.	− 11·45° C.
4	− 5·82° C.	− 0·6° C.	+ 3·2° C.
3	+ 6·86° C.	+ 13·0° C.	+ 15·6° C.
	w = 50 m.		
8	—	—	− 25·7° C.
6	− 34·98° C.	− 17·47° C.	− 10·37° C.
4	− 10·07° C.	+ 7·3° C.	+ 14·44° C.
3	+ 16·62° C.	+ 34° C.	—
	w = 100 m.		
8	—	—	− 58·3° C.
6	—	− 33·67° C.	− 5·29° C.
4	− 31° C.	+ 38·9° C.	+ 67·3° C.
3	+ 62·3° C.	—	—

TABLE VI.—Aluminium.

σ	t at s = 40.	t at s = 80.	t at s = 160.
	w = 30.		
4	− 28° C.	− 23·67° C.	− 20·75° C.
2	− 15·5° C.	− 11·22° C.	− 7·85° C.
·5	+ 4·35° C.	+ 8·6 C.	+ 9·5° C.
	w = 50 m.		
4	− 50° C.	− 34·66° C.	− 24·8° C.
2	− 36·6° C.	− 21·03° C.	− 11·2° C.
·5	+ 2·3° C.	+ 18·3° C.	+ 27·7° C.
	w = 100 m.		
4	− 138° C.	− 83·4° C.	− 45·4° C.
2	− 129·5° C.	− 65·3° C.	− 17·0° C.
·5	− 3° C.	+ 61·4° C.	+ 99·5° C.

The sag for the various spans (w) and σ is given in Tables VII and VIII.

TABLE VII.—Copper.

σ	Sag in cm. for w = 30 m.	w = 50 m.	w = 100 m.
8	12·20	33·0	132·3
6	16·3	44·1	176·4
4	24·45	66·5	264·6
3	32·6	88·2	352·8

TABLE VIII.—Aluminium.

σ	Sag in cm. for w = 30 m.	w = 50 m.	w = 100 m.
4	7·6 cm.	21·0	84·2
2	15·2	42·1	168·4
·5	60·8	168·4	673·6

The curves in figs. 3 and 4 represent the data above tabulated. These curves show that with the same coefficient of safety smaller wires should be given a larger sag than large wires. If, therefore, wires of various sizes are given the same sag, the small wires will be subject to a much greater strain per unit of section than the large ones. I think the tendency is to string small wires tighter than large ones, and taking this into consideration, we shall find, as previously pointed out, that under no circumstances should a smaller wire than No. 3 S.W.G. be used, while for spans of 50 to

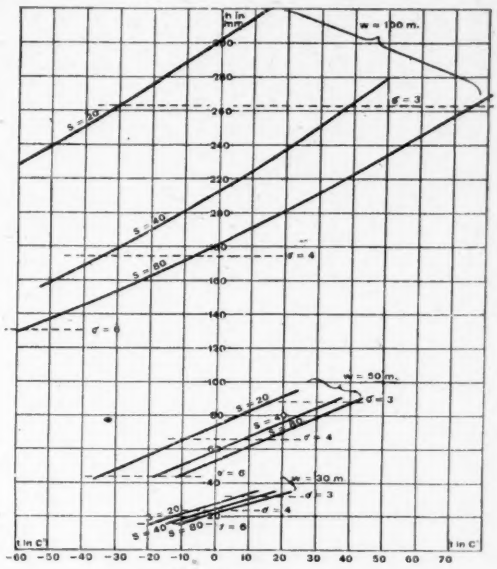


Fig. 3.—Copper.*

100 m., it is necessary to increase this minimum size of wire to be used to No. 2 or even No. 0 S.W.G.

As regards the curves for aluminium wires, these show how difficult it is, owing to the great variation in the strain and sag due to fluctuation in temperature, to string a transmission line of aluminium without exceeding the maximum limit at minimum temperature. As regards strength, I do not think that aluminium compares favourably with copper for transmission line purposes, especially where long spans are used.

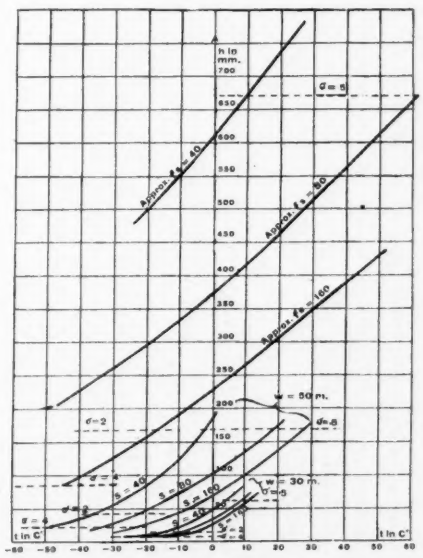


Fig. 4.—Aluminium.*

Poles.—Wooden poles are used as a rule, but lately also iron poles, especially in connection with long spans. In countries where wood is rather expensive, I think iron poles should receive more consideration than is given them at present. Whether they can be used to full advantage by adopting long spans is, of course, a question which has to be studied in each individual case.

* The figures are not strictly in agreement with the tables. In fig. 3, for w = 100 m., σ is 8, 6 and 4, not 6, 4 and 3 as shown.—Eds. E.R.

As regards cost, a wooden creosoted pole with iron cross-arms for, say, six wires, including insulators and erection, costs about £3 to £4, depending upon the voltage and whether the pole has to be stayed or not; while an iron pole with cross-arms for, say, six wires, including insulators and

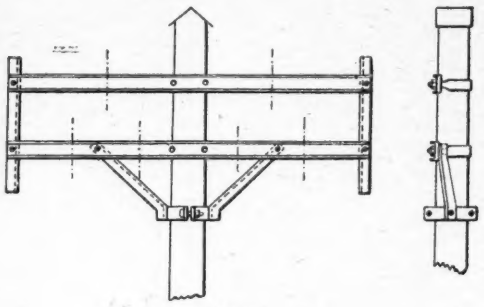


Fig. 5.

erection in concrete foundation, would cost about £9 to £10. With wooden poles we may say the average length of span seldom extends 33 m. The first cost would thus be lower for iron poles than for wooden ones, with an average length of span of about 100 metres.

Taking maintenance, depreciation and interest into consideration, we shall probably find that at an average length of span of 40-50 m. the use of iron poles will turn out cheaper than the use of wooden poles.

The size of wooden poles varies from 6 in. to 8 in. dia. at the top, depending upon the size and number of wires they have to carry. They are placed about 6 ft. in the ground. For iron construction lattice poles are used, these being cheaper and stronger than tubular poles.

Cross-arms.—Wooden cross-arms are used in many cases, but I consider this bad practice, and should say iron cross-arms are to be preferred. In the first case, iron cross-arms are much stronger than wooden ones; and in the

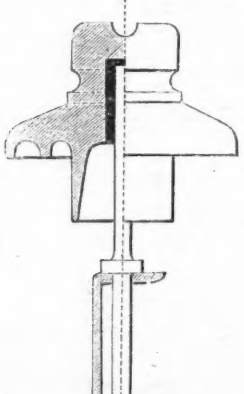


Fig. 6.

second case, if the wire drops from the insulator on to the wooden cross-arms it remains there unnoticed. In many cases the cross-arm and pole start burning, causing a breakdown of the whole line; while if iron cross-arms well earthed are used in connection with star-connected generators, the breaker in the generating station will immediately open the circuit, thus preventing burning, and at the same time indicating that something is wrong. Channel iron of 3½ in. × 2 in. × 2 in., or 4 in. × 2 in. × 2 in. section is a suitable size, and should be fixed to the poles by means of straps, as shown in fig. 5, and not by means of bolts.

Guarding and Earthing.—The cross-arms should be provided with vertical irons at each end to prevent the wires from falling down from the cross-arms in case the insulator or tie wire breaks. Where the transmission line crosses roads, railways or other wires, it is further necessary to put a guard netting underneath and at the sides of the transmission wires, as shown in fig. 7. This netting should be efficiently connected to earth—where foreign wires cross the transmission line a similar protection should be provided above the line. Another safety device sometimes used is shown in fig. 8. The idea is that in case one of the wires breaks, it will strike the metal guard before it falls to the ground. This may be satisfactory in most cases, but it is a question whether it is absolutely safe when the guard is covered with snow and ice. In this connection it should be pointed out that it is advisable to earth the pole itself in addition to the cross-arms. The earth wire used for the cross-arms can also be used for earthing the pole by slinging it two or three times round the pole. A galvanised iron wire No. 8 S.W.G. is generally used and is fixed to the pole by staples.

Tests have been carried out on a 7,000-volt transmission line with unearthed poles. The wire of one phase was placed on the cross-arm, while the wire of the second phase was placed on the cross-arm of a neighbouring pole: a voltage difference of about 350 volts was found between pole and "earth," and a voltage difference of about 300 volts per metre run of the pole. On earthing one of the poles a voltage difference of about 650 volts was measured between "earth" and the unearthed pole, and a voltage difference of about 550 volts per metre run of the pole for the first 3 metres from the ground.

Insulators and Bolts.—Porcelain insulators are, as a rule, used in Europe.

In selecting an insulator it should be borne in mind that it is of just as great importance (1) that the insulator be provided with a strong shoulder and neck; (2) that it be designed to transfer the strain of the wire to the bolt without leverage on the insulator; and (3) that it be grooved to fit the wire to be used as that it should have a good insulation surface. The insulators are either screwed on to the bolt, or fixed by means of sulphur, cement, or oiled hemp. The last method seems to protect the insulator in the best way from cracking, and at the same time gives sufficient mechanical strength. As regards bolts, ⅝ in. galvanised iron bolts are used for small wires, but for wires above ·1 sq. in. section, bolts of ¾ in. diameter should be used unless the conditions are exceptionally favourable.

Erection.—In erecting the poles sharp angles are to be avoided, and where a change in the direction of the transmission line is necessary the latter should be carried in a long "sweep." Care should be taken that the insulators on three consecutive poles are, as nearly as possible, mounted in the same plane, so as to avoid sharp vertical angles. The ordinary insulator is not designed to take vertical strains, and the contraction of the wire due to fall in the temperature will either break the tie-wire or lift the insulator from

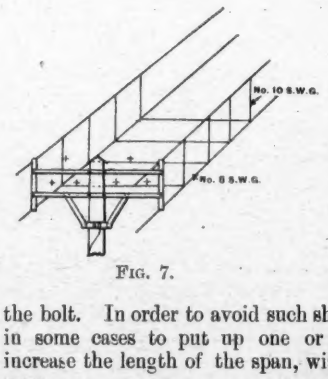


Fig. 7.

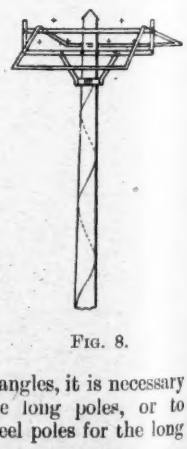


Fig. 8.

the bolt. In order to avoid such sharp angles, it is necessary in some cases to put up one or more long poles, or to increase the length of the span, with steel poles for the long span.

Copper Wires.—The copper wires should be semi-hard or hard-drawn. Larger conductors than ·2 sq. in. section should be avoided, as they are very troublesome to erect. If a much larger section than ·2 sq. in. is required per phase or pole, the conductor should be split up into two or more wires, as the case may be.

Spacing of Insulators.—A general rule regarding the distance between the insulators cannot be given. For pressures up to 40-50,000 volts, a distance = 3 $\sqrt[4]{E}$ in. will in most cases be found sufficient, unless long spans are used. In the above formula E represents the voltage. The minimum distance should not be less than 12 in. to 15 in.

For pressures exceeding 15-20,000 volts, it will be found that the placing of more than one three-phase circuit on each pole line will lead to rather poor arrangements, unless steel poles and cross-arms are used. For pressures above 50,000 volts it will be found pressures necessary to place the insulators at a greater distance than the above formula would indicate.

Static Discharge.—This is not very large for pressures up to, say, 50,000 volts, but when the pressure is increased to 60,000 volts or above, it becomes a serious matter. The

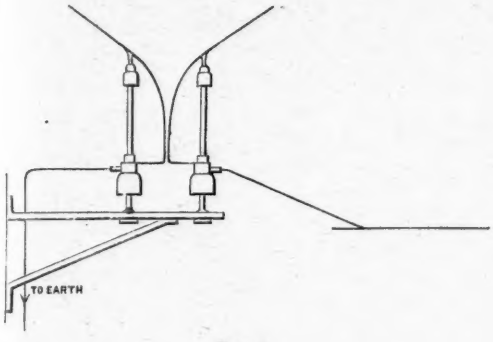


Fig. 9.

static discharge depends, naturally, to a great extent on the climatic conditions.

Extensive tests have not, as far as I know, been carried out. On the Telluride transmission line, Colorado, some tests have been carried out, the results of which were as follows :—

TABLE IX.—Watt Loss per km. with 4·3 mm. Wire.

Voltage.	At 38 cm. distance between wires.	At 132 cm. distance between wires.
40,000	94	52·5
44,000	254	58·8
47,300	768	76·6
50,000	—	87·5
54,600	—	140·5
58,800	—	760·0
59,300	—	885·0

A loss of 885 watts per km. would mean a total loss of about 175 kw. on a 200-km. transmission line. This, in addition to surface leakage and ohmic losses, is too much in most cases. By increasing the distance between the wires to 200-300 cm., we may expect a loss of 150 or 200 watts per km. The above, however, shows that at a voltage of 60,000 and above, the static discharge has to receive careful consideration.

Table X gives the distance between the wires at various voltages at which the effect of the static discharges begins in accordance with Prof. Ryan's theory, whereby the diameter of the wires is also taken to be 4·3 mm.

Table X.

E voltage.	Distance between the wires in cm.
43,600	38
46,800	56
50,700	89
54,000	132

In the above E is the effective voltage, and the max. voltage is taken to be = 1·71 E.

In this connection I would point out that the effect of the discharge depends to a great extent on the diameters of the wires. This begins at a much lower voltage for small wires than for large ones.

Table XI gives some idea regarding this ; the table is also drawn up in accordance with the said theory, for an average distance between the wires of 122 cm. at 21° C., and a barometric pressure of 760 mm.

Table XI.

E voltage.	Diameter of wire in mm.
55,000	1·47
83,300	2·69
111,100	4·87
166,000	10·9
222,200	18·0
277,700	25·1

Lightning Protection.—The so-called lightning arresters are supposed to protect against lightning discharges as well as atmospheric discharges. The types mostly in use are :—

1. The horn type arrester, which consists of two copper wires bent as shown in fig. 9, one wire being connected to the overhead conductor and the other connected to earth. The distance between the horns should be about 1 mm. for 1,000 volts, with a minimum distance of 2 mm. if the arrester is installed inside a building, and a minimum distance of about 5 mm. if it is mounted in the open.

2. The Wurtz type lightning arrester, which consists of a series of air gaps with shunt and series resistance to earth.

Lightning arresters are provided where overhead wires leave or enter a building—one for each wire. If the transmission line is long and exposed, lightning arresters are also placed along the line at suitable places. Each lightning arrester should be provided with an efficient earth plate either of cast-iron or tinned copper of at least 10-15 sq. ft. area.

On high-tension transmission lines, for, say, 30,000 volts and above, the lightning protection is an important matter, and it has been found good practice to install several arresters of different types in parallel.

Over-voltage.—On long transmission lines, especially in combination with cables, in many cases over-voltage is liable to break down the insulation and cause trouble. Fuses preventing a breakdown due to excessive current have, so to say, always been used, while voltage-limiting devices, with the exception of field-discharge resistances, have only lately received consideration. I presume many a breakdown ascribed to "bad insulation" is in reality due to over-voltage.

It is claimed by many that the lightning arrester takes care of over-voltage. This may be, to a certain extent true, in so far as it takes care of a high over-voltage.

A sensitive voltage limiting device must have a small air-gap, and as the discharge is small, it can have, or should have, a large resistance to earth.

These two conditions would make it unsuitable as a lightning arrester, which has to take care of heavy discharges. Some of the cable manufacturers insert a weak insulation in their joint boxes. Such boxes are provided with pilot wires, which indicate breakdown at a particular point. This arrangement may cause inconvenience, but still it is to be preferred to an "unexpected" breakdown, which may cause considerable damage and require time to locate. Lately a device has been used in Europe, and also in America, which, I understand, has given very satisfactory results. This simply consists in connecting the wires to earth by means of a resistance ; the latter is so large that the current at normal voltage does not exceed ·1 to ·2 ampere per phase.

On a 50,000-volt transmission line this would, of course, mean a loss of 5 to 10 kw. per phase. Still, this is not a serious matter where several thousand kilowatts are transmitted, and where only a few points need such a protection.

The voltage rise, or "over-voltage" referred to, is caused by resonance of harmonic waves of higher degree. The lower the periodicity of these waves, the more "dangerous" they are. A high capacity causes a low periodicity, and this is why large armoured cables possessing a high capacity are liable to breakdown, especially where energy is being supplied to motors only. Where incandescent lamps are being fed the danger is not so great.

The reason is evidently that the resistance of the lamps resisting the waves is very high, whereas that of the motors is comparatively low, and the E.M.F. of the motors does not counteract the waves of higher degree.

D

THE EFFECT OF EARTH RETURN CURRENT ON IRON PIPES.

Very little actual experimental work on the effect of earth return currents on gas and water pipes has been done, and the extended series of tests dealing with the problem from an electro-chemical point of view, which is being carried out in Germany by Messrs. Haber and Goldschmidt,* should lead to useful results.

Mere inspection of the attacked objects is insufficient. Cast-iron pipes appear little changed to the eye, and although the surface becomes soft under the action of the current, the same result has been known to occur where the presence of any return currents is quite out of the question.

In the new tests measurements of voltage were made by means of special non-polarisable electrodes, whilst current measurements were made by a form of coulomb-meter. The special electrode is shown in fig. 1; it consists of a glass tube closed at the bottom by an earthenware pot cemented on. The tube is filled with a saturated zinc sulphate

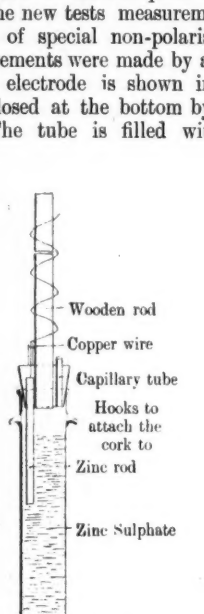


Fig. 1.

Fig. 2.

solution into which a zinc rod dips. The whole can be hermetically sealed at the top or, when desired, air can be admitted through a capillary tube. A wooden rod is provided to facilitate handling. Such an electrode is non-polarisable, *i.e.*, no internal E.M.F. will be set up between two of them placed in the earth, and so it is suitable for investigating potential differences in the earth and determining the direction of current flow.

The coulomb-meter used is shown in fig. 2 and consists of two bare metal plates held in a wooden frame and surrounded by a saturated solution of suitable salts containing an excess of undissolved salt. If the two plates are separated by a sheet of mica and are connected through a low resistance milliamperemeter, they serve to indicate the intensity of an earth current, provided the instrument is of suitable range and that the introduction of the plates into the earth does not disturb the current distribution. If, on the other hand, the two plates are laid directly in contact, without the insertion of an insulating layer, the change in the weight of the plates forms a measure of the total quantity of electricity which has passed through the plates.

This coulomb-meter is also non-polarisable. It should, as far as possible, be laid with its plates normal to the direction of current flow, this direction at any one point being readily determined from the potential difference readings. The small dimensions of the plates prevent any appreciable disturbance of the current distribution.

For the purposes of such an investigation, it is not sufficient to know merely the strength of the current leaving the pipes; it is of the greatest importance to know also whether the iron is "active" (liable to disintegration) or "passive" (capable of resisting attack). The ease with which iron is attacked follows Faraday's law, in accordance with which a current of 1 ampere flowing from the pipe into the earth for one hour destroys through oxidation $(1 - x) \times 1{\cdot}024$ grammes of iron and liberates $x \times {\cdot}298$ gramme of oxygen. For the limiting value of $x = 0$, the whole current is active in destroying the iron (active state), whilst for the other limit of $x = 1$, no iron is disintegrated, but oxygen is given off (passive state). This passivity may be considered as due to the presence of a thin, possibly porous, coating of oxygen. The question as to whether the iron is passive or active is determined by the electrolyte, *i.e.*, in this case the nature of the ground.

The chemical effects of electric currents on iron are similar to the rusting of iron, and substances which encourage the formation of rust help the disintegration, and *vice versa*. Rust is encouraged most by chlorides, as they destroy the initial protective layer of rust by alkaline reaction. Sulphates are almost neutral in their action, whilst nitrates distinctly discourage the production of rust. In the case of bicarbonates, the result depends chiefly on the presence or absence of free carbonic acid at the point of attack.

Besides combined hydrochloric acid, the presence of free carbonic acid in the surface water is especially dangerous.

There is no actual lower limit to the potential difference which can cause deposition of iron. In the case of "passive" iron no voltage will cause deposition, whilst in the case of "active" iron continuous electrolysis may occur with only just sufficient voltage to dissipate the hydrogen formed at the cathode. As the pipes or rails which act as cathode lie in earth containing plenty of air, they are automatically depolarised. The change from "passive" to "active" iron depends less on the voltage than on the current density. In practice, of course, very small voltages may be considered as harmless, since appreciable effects are only produced by them after a number of years.

In determining the conductivity of the earth, the writers employ the Kohlrausch-Holborn rule, in accordance with which the specific conductivity per cm. cube at 18° C. for very weak solutions is given by the number of milligrammes of the salt per litre divided by $\cdot 75 \times 10^6$. In this way the conductivity of 1 metre cube of earth was found to be about 125 ohms. In order to determine the surface resistance between pipe and earth, the resistance between a column of liquid and a small area on the surface of used and unused pipes was measured and found to equal about ·03 ohm per sq. metre. Allowing for the non-conducting particles in the soil, this figure would increase to about ·2 ohm per sq. metre. These low values are due to the fact that the tar coating is cracked at innumerable points. It is clear from the above values that the earth resistance rather than the contact resistance will determine the current distribution.

The contact resistance might be increased by insulating the pipes, but this would increase the danger of rapid pipe destruction in case the insulation broke down at points, and so encouraged high current densities there. Again, if the pipe is not "active" all along but "passive" at certain points current will not be able to leave at these "passive" points without overcoming the considerable counter E.M.F. due to the oxygen polarisation at the anode, so that the current density and the rate of decomposition at the "active" parts will be increased.

The current density can also be increased at certain points by the fact that the products of decomposition themselves increase the conductivity of the earth. Sometimes an attacked pipe will continue to be eaten away by ordinary rust action without any further passage of current. The presence of high conductivity zones in the earth is also dangerous on account of the localisation of the current. A high current density at the pipe surface may, in material containing carbonic acid, cause trouble through transforming iron in the passive state into active iron. Thus, iron in an alkaline carbonate solution is passive, but in the presence of the same solution containing free carbonic acid it is easily disintegrated. This state of affairs may be produced by the current itself, unless care is taken to facilitate the constant renewal of the electrolyte immediately surrounding the electrode.

Reversal of the current is only effective in particular cases

* *Zeitschrift für Elcktrochemie* and *E.T.Z.*

depending on the nature of the ground. If the passage of the current in one way causes an increase of carbonic acid, or of chlorides, in previously alkaline surroundings, a reversal of current will be useful, but with a decidedly acid composition no benefit is obtained. For the same reason alternating currents may cause a certain amount of disintegration.

The practical experiments at Strassburg with the test electrodes showed the following results :—At a certain point the voltage difference between a water pipe and the rails was ·01 to ·02 volt at night, and increased to ·8 volt during the day. Voltage drops amounting to ·2 volt were measured in the earth. The current flowed from the water pipe to the rails, and it principally left the pipe at the side facing towards the rails, showing that it flowed practically directly to the rails without deviation towards the feeding points. The iron was "active," but no signs of disintegration could be traced. Surface air withdrawn from a depth of $1\frac{1}{2}$ metres contained from 1 per cent. to 8 per cent. of carbonic acid. The variations in voltage drop with load became less and less marked the greater the distance from the rails.

The results of the writers' experiments up to the present have led them to the following conclusions :—

The earth conducts electrolytically and not metallically.

Disintegration only occurs when the iron is in the "active" and not when it is in the "passive" state.

Since the state of the iron depends on the chemical composition of the earth, the ground conditions decide whether the iron is in danger or not.

Increased diffusion of the current is advantageous, and anything which interferes with this diffusion is to be avoided.

Reversal of current is only advantageous in certain cases.

High current density may in some cases convert iron from the passive to the active state.

Pipes attacked chemically are not readily distinguished by eye from those attacked electrolytically.

In the active state disintegration takes place even at the smallest voltages, but voltages below about 1 volt are not usually appreciably harmful.

CORRESPONDENCE.

Letters received by us after* 5 p.m. on Tuesday *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

Whittaker's Electrical Engineers' Pocket Book.

Perhaps you will allow us a little space in which to refer to the review of "Whittaker's Electrical Engineers' Pocket Book" in your issue of August 17th. May we say that your Reviewer seems to have been rather unfortunate in holding up to us "Hospitalier's Formulaire" as a model of accuracy? We have no desire to disparage this excellent little volume, but it is nevertheless a fact that in using it recently for the first time we found in three consecutive pages two errors in important formulæ, and one complete misstatement of fact. These errors will be found on pp. 314 and 317 of the latest (1904) edition. We think we may hope that after 20 editions of the volume to which we contributed, we may attain to at least an equal degree of accuracy.

On p. 96 we stated that for small magnetising forces the permeability of iron is small. Compared with *air*, it is, of course, large. But we proceed to show that it increases later to a maximum, and is, therefore, *initially* small. We do not think there can be much misunderstanding here by the ordinary reader.

On p. 102 perhaps the expression "other things being equal" will not bear the light of exact mathematical criticism (neither will Euclid), but we believe here also that the meaning is clear.

The statement on p. 107 *re* current growth is correct. The current will continue to grow at the rate of V/L amperes per second so long as the V volts acts on the L henries.

As to the explanation of "skin effect," we really do flatter ourselves that our explanation puts the matter pretty clearly to a practical man, if not to a mathematician. Why attempt to drag in mathematics to assist in the explanation of "skin effect?" We were not attempting to calculate *its value* for any particular case.

Referring to the strictures on p. 127, your reviewer appears to have overlooked the context. The formulæ given are only intended to apply to electric radiation. They were taken from the *Electrical World*, of New York, and are, of course, only approximate. As far as we have been able to check them, and barring three printers' errors, two of an obvious character, they appear to give fairly accurate results.

If your reviewer will refer to the complete formulæ for determining L in case 2, including corrections for the distribution of current in the rods and plates at the frequency obtained, also corrections due to the spark gap, the reasons for not publishing such in a pocket book of this character will be sufficiently obvious.

We have not been able to find the complete formulæ in every case, so have not determined the degree of accuracy obtainable with the formulæ given. On referring to Hospitalier for information, we found the only information bearing on the case was a mis-statement of fact.

We may say, in conclusion, that the pocket-book does not pretend to be a mathematical treatise, but only a compilation for use in the everyday problems of electrical engineering.

R. C. Clinker.
E. B. Wedmore.

Rugby, *September 14th*, 1906.

[Our Reviewer's reply will be found in our "Notes" columns.—Eds. E.R.]

Manufacturers Selling Direct to Consumers.

Referring to the above matter in this week's Review, I wonder what engineers of supply stations would think of, and the treatment they would give to, a certain wholesale firm of electrical plant and accessories whose traveller canvasses our town for two or three days, and quotes certain of our largest consumers for dynamos to enable them to install their own generating plant, their excuse being "a previous inquiry?"

What with gas at 2s. 10d., the advent of the inverted burner, and an *enemy like the above in our own camp*, the fight here promises to be interesting.

H. L. Alverton,
Engineer and Manager, Guildford Electricity Supply Co., Ltd.

Guildford, *September 14th*, 1906.

Apropos of recent correspondence on this subject, I give you a case of supplying to the trade. I recently ordered through a firm of factors an electrical article advertised in trade papers at 4s. 6d. subject. They ordered from makers, when the following correspondence took place :—

1. "Your esteemed order to hand, &c., &c., not having done business with your esteemed firm before, on receipt of P.O.O. for 4s. 6d. we will forward on. Yours, &c."

2. "On receipt of invoice, we shall be pleased to remit, but surely price is not 4s. 6d. net, where is trade discount? Yours, &c."

Pro forma invoice was then received for 4s. 6d., less 20 per cent., plus 4d. for "postage and packing" = 3s. 11d. This was sent and goods arrived, 8d. carriage to pay. On complaining *re* carriage, makers replied 4d. was only *for packing*, goods could only be sent free in lots of 100. The cost to the trade was, therefore, 4s. 7d. (plus postage on correspondence).

Another customer wanted to place an order for half-a-dozen as samples, but the firm would not entertain it; is it to be wondered at? As the situation remains, I must either order direct and pay about 5s. or find a firm who will pay 4s. 7d. and sell to me at 4s. 6d.; or go without. I know which course I shall take.

Private Plant.

Derby, *September 17th*, 1906.

Electric Pumping at Collieries.

Will you kindly allow me a small space to explain two or three points which you seem to have overlooked in your criticism on my paper on "Electric Pumping at Collieries."

I am always thankful for sound criticism, but every paper has to be criticised as to its value, with due regard to the object the author had in view. My object was to put before an assembly of mining engineers the advantages of electric pumping underground as compared with pumps driven from the surface, or with underground steam pumps; and also to show the work which has been done abroad where underground electric pumping installations exist, with which at the present time, as far as capacity is concerned, we have nothing to compare in this country. In such a paper, to give prices based on imaginary conditions, which are, of course, bound to vary in every case, is, in my opinion, worse than useless, and only leads to endless and fruitless discussions, as we have witnessed in the case of "Electric Winding."

The same applies to sectional drawings in a paper where general conditions are being discussed. Each case has to be considered on its own merits, and I daresay that there may be special cases where a direct-driven steam pump may be cheaper in running and first costs, but these cases are few and far between.

The heavy repairs on underground steam pumping installations, to which your contributor seems to take exception, are, of course, almost entirely due to the leaky and badly looked-after steam ranges in the shaft, but may also, in certain cases, include repairs on separate boilers, steam pistons and valves in pumps which require far more repairs and maintenance than a cable, and a direct-coupled induction motor.

As to "how water can be made clear by passing it through a centrifugal pump," I am equally at a loss to explain, but if you will kindly read the passage on p. 4 again, the meaning may become clear to you. The mine in question is an iron mine where the pit water is, of course, not so dirty, and where the water was being used for the boilers. It would have been, of course, much dirtier if it had been allowed to percolate through all the workings to a sump, and brought to the surface by the means of a single pump; instead of which it was taken to the surface from the proper inflow levels. An installation of this kind, however, necessitating a great number of small pumps, working in series, can only be effected at reasonable cost by installing electrically-driven centrifugal pumps.

Gerald Hooghwinkel, M.I.E.E.

London, S.W.,
September 15*th*, 1906.

Charging Accumulators.

I shall be glad if any of your readers can tell me the cause of the following:—I had occasion last week to charge a new battery, using for this purpose a 10-B.H.P. Stockport single-cylinder gas engine running at 220 R.P.M., an E.C.C. compound-wound dynamo, 100/135 volts, 89 amperes, 965 R.P.M. belt driven, the series winding being plugged, using dynamo as a shunt machine. At 112 volts 50 amperes we commenced the charge; the voltmeter pointer remained practically steady, but the ammeter pointer swung so much that it was almost impossible to tell what current was being generated; but as the voltage rose the ammeter pointer became steadier; so much so, that towards the completion of the charge it was hardly sufficient for complaint. I noticed previously in running the machine as a compound direct on the lamps both instruments were affected, but the whole time the swinging was much less. It appeared to me to take place about the same time as the charge in the cylinder was fired, although it was greatest when the governor cut out. I shall be glad if someone will inform me whether it is due to this cause or not, as I have been given to understand that *speed* cannot affect the amperes.

G. A. K.

Reading, *September* 15*th*, 1906.

[Certainly the speed affects both volts and amperes; and periodic variations of speed are unavoidable when a dynamo is driven by a single-cylinder four-cycle gas engine. Running on lamps, the resistance in the circuit is practically steady, though it tends slightly to diminish with increase of pressure and current; the field at the low voltage is weaker than when charging the battery, and less stable, while it is acted upon both by the shunt ampere-turns (which vary with the pressure) and by the series ampere-turns (which vary with the current). Thus a slight increase in speed augments the E.M.F., this increases the current slightly more than in proportion, and both the increase in pressure and the increase in current combine to increase the field; consequently the voltage variations under these conditions are magnified, and both instruments are unsteady.

When charging a battery, the field is stronger and more stable, while it is, if anything, weakened by increase of current. The effect of the pulsations of speed on the E.M.F. is therefore much less than when feeding lamps. On the other hand, a large portion of the E.M.F. is balanced by the back E.M.F. of the battery, the portion which provides for the C × R voltage being, say, only one-sixth of the total. Hence a fluctuation of 1 per cent. in the total voltage becomes 6 per cent. of the effective voltage, and produces correspondingly great variations of the current, which account for the vibration of the ammeter needle. At the low load the gas engine governor would cut out more frequently than when the battery approached full charge, the voltage being then higher and the load correspondingly greater; this would partially account for the greater steadiness of the pointer towards the end of the charge. The internal resistance of the battery increases considerably during the charging process, so that with equal total fluctuations, the percentage variation of the *effective* voltage is greatly diminished. These considerations together, we think, fully account for the observed phenomena.—Eds. E.R.]

Testing Supply Networks.

It may save some disappointment to central station engineers who are about to test their networks before the winter load comes on, if I point out a "nigger" in the test described on page 278 of your issue of August 17th. If the test were made as described, and with the connections as in fig. 2, the result would be that $P_1 = P_2 = P_1' = P_2' =$ half the bus-bar voltage, and the equations for the fault-resistances of the mains would simply be in the indeterminate form $\frac{0}{0}$.

To obtain any result at all, it would be necessary to insert a resistance in series with ammeter A, at least of the same order of magnitude as the fault resistances which are to be determined; but even then the equations given in the second column of page 278 are not correct.

My letter is somewhat belated, because I have been enjoying a holiday far away from the conventions of Ohm, where (as you see) the Lancashire dialect has penetrated, but not the Electrical Review, in an island governed by its own laws, and in which those of Kirchoff are unknown.

F. Charles Raphael.

London, E.C., *September* 11*th*, 1906.

Bowling Green.—A correspondent asks advice as to the best way of lighting a bowling green with glow lamps; two rinks, total area 102 ft. × 73 ft.; lamps suspended from steel poles.

IMPROVING TELEPHONY.

A suggestive paper by Mr. W. Duddell was read at the Royal Institution ("How to Improve Telephony," March 16th, 1906), and several points which the ordinary man is rather apt to overlook were brought prominently forward. The author states:—

The sensation of sound, as is well known, is produced by the vibration backwards and forwards of the particles of the air about their position of rest, and the character of the sound depends on the quickness and the form of the vibrations. Thus, in the case of a musical note, the air particles vibrate in a perfectly regular manner, and the number of complete vibrations in a second, or the frequency, determines the pitch; and the amplitude, or distance the air particle moves from its position of rest, determines the loudness of the note. In speech, however, the vibrations are very complex, and in order to form any clear mental idea of their character, it is

necessary to represent the movements as curves, which I will call sound patterns. Various observers have made records of these patterns; among the earliest and best are those obtained by Fleeming Jenkin and Ewing (Edinburgh *Phil. Trans.*), who magnified the impression obtained on the cylinder of a tin-foil phonograph. Figs. 1 to 6 are some typical sound patterns obtained by another method, to be explained later, which illustrate how very complex the movements of the air particles become in the case of speech.

The problem in telephony is the accurate reproduction at a distance of these complex vibrations of the air; the more nearly the movements of the air at the receiving point correspond to those at the transmitting point, the better will be the quality of the telephony. If the movements at the receiving station are similar in pattern but of less amplitude than those at the transmitting station, then we have simply attenuation of the sound; if, however, the sound pattern at the receiving point is distorted, then loss in articulation takes place. It happens, very luckily, that the ear has a wonderful power of recognising a sound pattern even when considerably distorted; if it were not for this latitude, as we may call it, in transmitting our sound pattern, telephony would not be practicable over anything like the distance already attained.

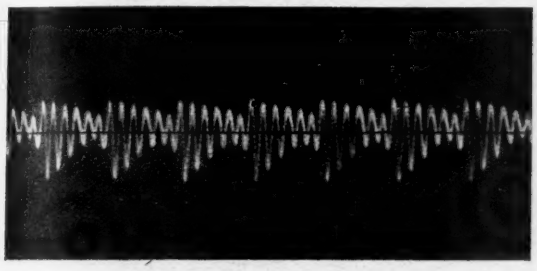


Fig. 1.—Vowel ā in Ma.

The two curves here reproduced, figs. 1 and 2, were obtained by means of a Duddell oscillograph.

As regards the losses which occur in telephony, the paper proceeds :—

> The movements of the air are first converted into movements of a diaphragm, which movements are again mechanically transmitted to the carbon grains in the microphone, thus altering its electrical resistance. The varying resistance of the microphone causes the current through it and the connected transformer to vary, and so induces varying currents in the secondary of the transformer. This secondary is connected to the line, so that the currents are conveyed to the receiver at the distant place. The currents are here transformed into a varying magnetic field, which acts on a diaphragm

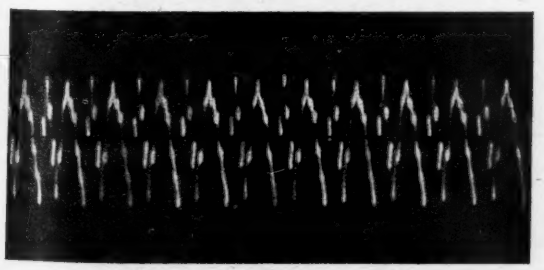


Fig. 2.—Vowel ē in Me.

> and causes it to vibrate and thus start the air around it in movement. In all this long train of transmissions and transformations the character of the original sound pattern must be preserved sufficiently well to enable the ear to recognise it in its final form. When we consider that at every one of these steps distortion and loss of energy must take place, it is not surprising that there are difficulties in the way of telephony. In fact, it is a matter for wonder that electric telephony is possible at all.

It is indeed curious to think, as remarked by the author, that, although telephones are manufactured by the million, yet so little research has been done until quite recently with a view to improving the instruments. The receiver to-day is practically identical with that of Graham Bell, while carbon transmitters differ only in detail from the earliest types. However, thanks to the instruments now at hand, this will probably undergo a change ere long. Mr. P. E. Shaw has shown (*Proceedings*, Royal Society, LXXVI, p. 350-366) that a just comfortably loud impulsive sound corresponds to a movement of the telephone diaphragm of only one twenty-thousandth of a millimetre, while an amplitude of one fiftieth of this amount is still audible!

It is also mentioned that an ordinary telephone receiver diaphragm has a natural period of about 500 cycles per second, or an octave above middle C; so that certain notes are accentuated by resonance, when their period coincides with that of the diaphragm. This, of course, makes "distribution of music" rather difficult.

Methods of testing telephone apparatus are discussed, and it is pointed out that an alternator giving a sinusoidal wave of 2,000 cycles per second would be useful, so that results could be compared with theory. However, a strictly sinusoidal wave is difficult to obtain at present. Other methods of obtaining a high frequency current are—The Humming Telephone (Mr. F. Gill, *Journal* Elec. Engs., XXXI, p. 389, 1902); The Musical Arc (*Journal* Elec. Engs., XXX, 1901); The Musical Vacuum Tube, by shunting a vacuum tube supplied with high tension *direct* current in a similar way to the musical arc; and Mr. Campbell's vibrating bar (*Proceedings* Phys. Soc., XIX, p. 174, 1904).

It is interesting to note that the system of "loading" the line, due to Mr. O. Heaviside, appears likely to be used for long distances (*vide* Mr. H. V. Hayes, Inst. Elec. Congress, St. Louis, 1904).

Seemingly telephone engineers have at last the apparatus at hand to enable them to make a systematic experimental study of their somewhat complex business. The thermo-galvanometer enables the R.M.S. value of a train of waves to be compared with that of others, and with a view to studying the instantaneous values Mr. Duddell in the above paper states :—

> A more complete insight into the distortion produced by different parts of the apparatus and line can be obtained by gearing small mirrors to both the transmitter and receiver diaphragms, so that records can be obtained simultaneously of the movement of the transmitter diaphragm, the current flowing into the line or cable, the current flowing out of the line, and the movement of the receiver diaphragm. [With the above apparatus the effects produced by resistance, capacity, and self-induction, both separately and in combination, and also distributed, in the form of an artificial cable, were demonstrated during the discourse.]
>
> There still remains much work to be done in devising new methods of measurement, and in improving the present apparatus; nevertheless the existing methods and apparatus are already sufficiently perfect to enable a large number of investigations to be successfully undertaken.

With regard to the large number of transformations referred to above, and the consequent sources of loss, it is worthy of notice that Mr. T. Cahill (*Scientific American*, March 31st, 1906) has a system by which music is *generated electrically* at a central station, and distributed by means of wires to hotels, clubs, &c. Direct-coupled alternators are used, and these are controlled by an ordinary two-manual keyboard. Tone-mixing transformers are used, analogous in their effects to the mixing stop of an organ. Thus a prime alone produces a clear flute note; the clarionet, and other musical instruments, are imitated by introducing partials of different orders. The receivers are ordinary telephone receivers, so it would appear that certain notes will be accentuated as mentioned above.

With regard to the meaning of the term "inductance" in telephony there is a paper by Mr. J. G. Coffin (Amer. Acad. *Proceedings* 41, pp. 789-803, May, 1906), in which he shows that the variable part of the expression for the inductance in certain cases agrees with that derived from a circular current sheet which replaces the coil under consideration.

In addition to the troubles already referred to above, the telephone engineer will always suffer from those who speak, or articulate, indistinctly. The writer suggests that the oscillographic method of recording vowel sounds, &c., might be used in elementary schools to improve the speech of pupils, any peculiarities being rendered visible. How useful such an apparatus would be to the Scotland Yard authorities for the identification of criminals it is difficult to say, but it seems it might be tried, as each person will have his own peculiar "vowels," &c.

Harpenden Electric Lighting.—With the object of securing protective clauses, the U.D.C. has decided to oppose the application of the North Metropolitan Electrical Supply Co. for a prov. order for electric lighting.

ELECTRICAL STATISTICS OF JAPAN FOR 1905.

Japanese enterprise has not yet reached the stage of providing by private effort a financial encyclopædia of its electrical industries, such as Garcke's manual. The State, on the other hand, in its "Financial and Economic Annual," does afford some interesting information on the subject. Although this State-supplied information is not all-embracing, it does afford a few figures worthy of presentation to English readers.

Regarding Japan as a market in the first place, the following figures give particulars of imports, likely to interest our readers, during the past three years:—

Electric Motors.

	1903.	1904.	1905.
Germany	£11,949	£22,240	£16,677
Great Britain ...	18,493	22,849	42,364
United States ...	52,358	81,223	185,975
Other Countries ...	865	308	526
Total ...	£83,665	£126,620	£245,542

Steam Boilers and Engines (other than Locomotives).

	1903.	1904.	1905.
France	£1,946	£856	£2,170
Germany	5,053	1,671	5,596
Great Britain ...	53,527	125,264	164,385
United States ...	37,555	42,981	89,422
Other Countries ...	906	319	1,730
Total ...	£98,987	£171,091	£263,303

Cars or Carriages, Electric.

	1903.	1904.	1905.
Great Britain ...	£4,237	£11,137	£25,022
United States ...	3,706	78,370	27,613
Other Countries ...	5,535	1,070	425
Total ...	£13,478	£90,577	£53,060

Submarine Telegraphic Cables, and Underground Telegraphic Lines or Cables.

	1903.	1904.	1905.
France	—	£1,035	£2,433
Germany	£1,889	3,062	4,216
Great Britain ...	21,848	99,599	250,241
Other Countries ...	9,480	—	28
Total ...	£33,217	£103,696	£256,918

The British hold on these imports is certainly satisfactory.

As regards electric tramways, there are 18 undertakings in existence, having an authorised capital of £3,798,700, and a paid up capital of £2,620,342. The mileage open to traffic amounts in length to 131·1 miles, the equivalent track mileage being 215·14 miles. Under construction there is a length of 218·38 miles of track, of which the length open for traffic will be 82·33 miles. The rolling stock consists of 1,169 cars. These carried 124,457,612 passengers, the gross earnings being £415,320, and the net earnings £182,506. The amounts distributed in dividends by the dividend-paying concerns averaged 5·74 per cent., as against 4·98 per cent. in 1904, and 4·36 per cent. in 1903. These figures represent a great falling off from dividends averaging over 20 per cent. in 1896-7-8 on a few undertakings in the chief towns. Even in 1905 there are wide differences in the dividends declared among the dividend-paying concerns, these ranging from 3·00 to 15·00 per cent.

For the purposes of telegraphic communication the line mileage is 18,915, and the length of wires 88,809 miles. The number of messages sent was 21,222,041. The length of telephone lines installed is 3,264, and the actual length of wire 45,386 miles. The approximate number of messages sent was 148,464,559. All these telephones are under State control, telephone services being installed in 29 cities and towns. As far back as 1900 the cities of Tokyo and Osaka, which are about 350 miles apart, were connected by telephone.

A very interesting table is that giving the motive power used in various factories. Some 2,221 factories are steam driven, and in these the aggregate horse-power of 3,582 engines is 93,684. Water-power is used in 849 factories, the aggregate horse-power obtained from 650 water-wheels and 418 turbines being 5,801. Petroleum is used in 222 factories, 280 engines aggregating 1,212 horse-power being employed. The factories and undertakings in which the motive-power is electrical number 117, and the horse-power of the 170 motors used is 3,533. Factories and works in which the motive-power is electricity or steam are 87 in number, there being 615 engines, the horse-power of which is 43,374. It is impossible to comment on these figures as the conditions of classification are not defined.

Electric lighting, of which only the figures for 1904 are given, is undertaken by 71 companies. The authorised capital of these is £2,029,075, and the paid up capital is £1,538,057. The number of houses fitted with electric light is put at 80,548, the lamp connections being stated to be equal to 407,038 watts. This is surely an error as it would only provide an average of 1⅝ 30-watt lamps per house. The number of street lights is returned as 11,015, but no distinction is made between arc and incandescent lamps.

Lastly, we would note that the electrical industries employ a total of 720 male and 36 female operatives, of whom three males and one female are under 14 years of age. The average daily earnings of the male workers over 14 years of age is about 9·6d., as against 13·7d. for the workers in ship-yards and machine shops.

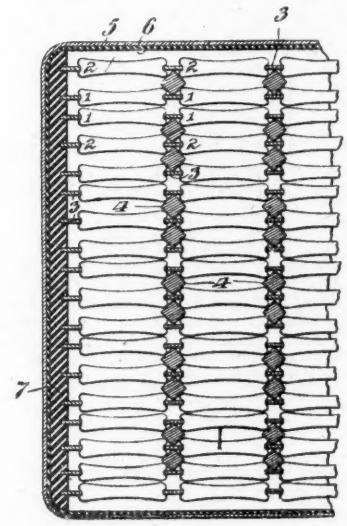
EDISON IRON-NICKEL STORAGE BATTERY

A description is given in the *Western Electrician*, of July 14th, of a new form of iron-nickel storage battery, for which a patent has been granted to Mr. T. A. Edison.

The invention relates to improvements in storage batteries of the type wherein the active materials containing, respectively, nickel and iron, are maintained under pressure in small pockets or receptacles made of perforated sheet metal and held in position in suitable grids.

In practice Mr. Edison found that, bulk for bulk, finely divided iron obtained by reducing ferric oxide is much more active electrolytically than the nickel hydroxide that he has so far been able to obtain commercially. Consequently to present the best combination for practical use the bulk of iron used need only be half that of the nickel.

If the attempt is made to employ pockets of nickel of twice the capacity of the iron pockets, the surface in contact with the metal walls is not large enough to provide for the proper discharge rate. Furthermore, such an arrangement would be undesirable commercially, for the reason that it would necessitate the employment of widely different machines for manufacturing and assembling the



Horizontal Section of New Edison Cell.

nickel and iron grids and also because the great bulk of nickel used would necessitate pockets of prohibitively thick metal in order to accommodate the swelling, and, finally, because with a thick mass of nickel the proper circulation of the electrolyte could not be secured.

By making the pockets for the nickel of substantially the same size as those for the iron, and by using twice as many nickel grids as iron grids, a practically useful combination is secured. Furthermore, the space between the adjacent nickel pockets provides opportunity for any swelling to take place.

The accompanying illustration is a cross-sectional view through one of the improved storage batteries embodying the invention and showing the preferred form of separators.

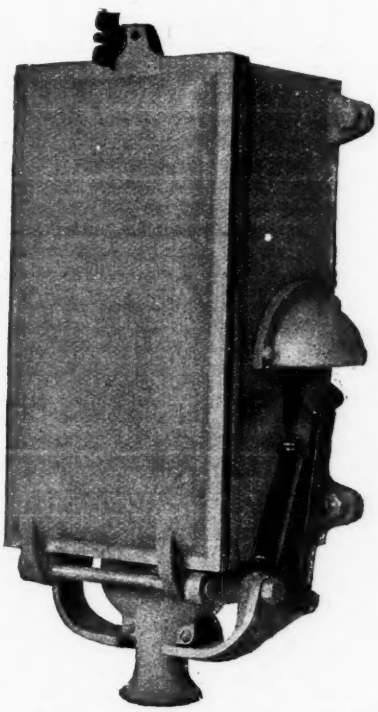
In the figure (1,1) represent nickel pockets, and (2,2) iron pockets, the former being arranged in pairs, as shown. The several pockets contain the active material in pulverised form and are secured in position within suitable grids (3) in the usual way. Insulating separators are employed between the iron pockets and the adjacent nickel pockets to prevent the pockets from contact due to the swelling of the active materials; but, preferably, separators are not employed between the adjacent nickel pockets, which may swell, so as actually to touch, without objection. By dispensing with separators between the nickel pockets space enough is obtained in which the entire expansion may take place. The separators preferably used are diamond-shaped in cross section. These separators are made of hard rubber, preferably by cutting a sheet into sections. The separators are so proportioned that each engages the rounded corners of four of the pockets, while at the same time the adjacent grids are spaced a distance determined by the length of one of the diagonals of each separator. With this arrangement the adjacent pockets will be always effectively separated.

The several electrodes are assembled in any suitable can or receptacle (5), lined with a sheet of ebonite (6) or other insulating material, and are spaced at their ends by slotted separating bars (7) in the usual way.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

New Device for Power Circuits.

Messrs. Dorman & Smith are introducing a very substantial form of interlocked double-pole switch and plug connector adapted for power circuits. The switch is of their well-known "C" type on high insulation porcelain base, with porcelain separator, and the plug, as will be seen from the illustration, is of a somewhat novel form, very easy to connect up to the flexible. To make this apparatus specially applicable for colliery work (gate end switches) the plug

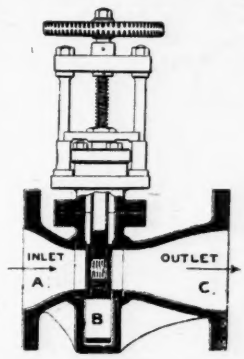


Interlocked D.P. Switch and Plug Connector for Power Circuits.

with its external locking gear, and if desired the glands for entry of main leads, are all arranged at the lower end of the box or otherwise under shelter so as not to be damaged by falls from the roof of the mine. The locking gear, which is designed to stand rough usage, fulfills all requirements. The plug cannot be inserted or withdrawn, or the box opened unless the switch is "off," and the switch cannot be operated when the box is open.

Hopkinson-Ferranti Stop Valve.

This is a speciality introduced by Messrs. J. Hopkinson and Co., Ltd., of Huddersfield, for enabling valves to be used having operative working parts of half the ordinary diameter, and so constructed that they will pass an amount of steam equal to the full carrying capacity of the pipe without appreciable drop in pressure. This is accomplished by forming the working parts of the valve in the throat of a "converging diverging" nozzle, and by a special construction of parts to give a smooth passage for the fluid when the valve is full open. The effect of this construction is to convert a small portion of pressure energy of the steam as it travels through the converging nozzle A into kinetic energy, the steam increasing in velocity and dropping in temperature and pressure. At the high velocity thus acquired it passes through the controlling part or valve proper. It now enters a diverging nozzle at high velocity, and its passage converts its kinetic energy into increased pressure and temperature until, at leaving the nozzle at C, it has returned to the same conditions of pressure, temperature and velocity with which it entered the converging cone A at the inlet side of the valve. Many advantages are claimed for this type of construction. The possible leakage is halved, because the perimeter of the valve disk and seat is one half that of an ordinary valve. The reduction in the size of these parts also reduces the warping with high temperature superheated steam, still further reducing leakage. There is only one-eighth part the work to do in opening and closing the valve. The graded opening prevents any sudden rush, no by-passes are



Hopkinson-Ferranti Stop-Valve.

required; all expansion and contraction are amply provided for. The disks, which, like the seats, are of Hopkinson's "Platnam" metal, are free to rotate on their axes, thus cleaning the faces.

LEGAL.

Firth & Son *v.* Cardiff Corporation.

This was an arbitration which it will be remembered took place before the long vacation before Mr. W. H. Patchell, M.I.E.E., M.I.M.E., M.I.C.E., and some references to the matter appeared in the Electrical Review at that time. Mr. Maurice Drucquer, M.A., LL.B., instructed by Mr. R. Tweedy Smith, solicitor for the Electrical Contractors' Association (Incorporated), appeared for the plaintiffs; and Mr. Sankey, instructed by the town clerk of Cardiff, appeared for the defendants. The arbitration extended over some five days, and was held in the High Court of Justice. The following account of the proceedings has been received by us. The plaintiffs had entered into a contract with the Cardiff Corporation to carry out certain work in wiring the Whitchurch Asylum, Cardiff, for the sum of £6,421. Before the contractors received a penny on account, they ceased work, and the Cardiff Corporation terminated the contract, and counterclaimed for the sum of £3,600. The contractors alleged that the engineer to the Cardiff Corporation, Mr. Ellis, had improperly withheld certificates, and made requisitions for work which was not set forth in the original specification. The contractors had completed work for nearly £1,500, but did not receive payments on account, although from time to time applications had been made for certificates, and information given to the engineer as to the amount expended for labour and material. Technical evidence was given as to the work which Mr. Ellis, the engineer to the Corporation, had ordered the contractors to carry out, which, it was contended, was not included in the original specification.

The counterclaim was in respect of expense to which the Cardiff Corporation had been put in having to make other arrangements for the boarding out of patients, at a cost of 5s. 3d. per head per week. The amount of the counterclaim was £3,600, and the number of patients boarded out was 600.

We are informed that the Arbitrator has now made his award, and he finds that—

1. A certificate was withheld within the meaning of Clause 26 of the contract which gave the contractors the right to suspend the works and deprived the Corporation of the right to determine the contract.

2. That the notice of November 29th, 1905, given by the Corporation terminating the contract was unreasonably and vexatiously given within the meaning of Clause 26 of the contract.

3. That the contractors did not fail for 14 days after the notice of November 29th, 1905, to proceed with the work so as to give the Corporation the right to determine the contract.

The Arbitrator found for the plaintiffs for materials delivered the sum of £979 16s. 2d.; for labour done, £287 16s. 7d.; reasonable profit, £154; making a total of £1,421 12s. 9d. He gave nothing to the Cardiff Corporation on their counterclaim, but ordered them to pay the whole of the costs.

Tantalum Ores.—Deposits of ore containing tantalum have been discovered at Henryton, near Baltimore, U.S.A. The ore is found in crystalline form embedded in felspar, and yields on analysis 38·19 per cent. of oxide of tantalum, and 13·21 per cent. of oxide of niobium. Tantalum ores have also been found at Glastonbury and at Tinton, the latter containing 44 per cent. of oxide of tantalum and 30·5 per cent. of oxide of niobium.—*Revue Industrielle.*

THE ENGINEERING AND MACHINERY EXHIBITION AT OLYMPIA.

This exhibition was declared open on Saturday last by Sir Alexander Binnie, and an inaugural luncheon followed, at which Sir W. H. White, K.C.B., the president, occupied the chair. The toast "Success to the Engineering and Machinery Exhibition" was proposed by Sir Alex. Binnie, who had a good deal to say concerning the engineering progress of the last half century or so. Sir W. H. White, in responding, said that the exhibition was supported by all the leading engineering societies of this country, and its exhibits were representative of the high standard of modern engineering. Mechanical training, which was well exemplified by the exhibition, was the foundation of all the other branches of the engineering profession.

The show is international in character, foreign firms being well represented among the 150 exhibitors.

A special effort has been made to gain the interest of the engineering students who are so numerous in these days. One feature that may be mentioned in this connection is the series of lectures that have been arranged as follows :—

Thursday, September 27th, at 8 p.m.—"Sewage Disposal." Bailey Denton, Esq.
Saturday, September 29th, at 7 p.m.—"Development of the Steam Turbine." The Hon. C. A. Parsons, M.A., C.B., and R. J. Walker, Esq.
Saturday, September 29th, at 8 p.m.—"Sanitary Science as Applied to Marine Engineering." A. E. Battle, Esq. (Member of Royal Sanitary Institute).
Monday, October 1st, at 8 p.m.—"Master Strokes of the Great Engineers." J. C. W. Haldane, Esq.
Tuesday, October 2nd, at 8 p.m.—Popular Lecture, "Japan and the Far East." George A. Goodwin, Esq., M.Inst.C.E., A.M.Inst.E.E., Whit. Sch., Past President of Society of Engineers.
Thursday, October 4th, at 8 p.m.—"Gas Engines." H. A. Humphrey, Esq., F.C.G.I., M.I.C.E., M.I.Mech.E., M.I.E.E.
Tuesday, October 9th, at 8 p.m.—"The Connecting and Disconnecting of the Power from the Work." Dr. H. S. Hele-Shaw, F.R.S., M.I.C.E., M.I.M.E.
Thursday, October 11th, at 8 p.m.—"Gas Engines." (Second Lecture.) H. A. Humphrey, Esq., F.C.G.I., M.I.C.E., M.I.Mech.E., M.I.E.E.
Monday, October 15th, at 8 p.m.—"Steam Pipes and their Explosions." C. E. Stromeyer, Esq.

Compared with the Exhibition which so excellently fulfilled its purpose in the autumn of last year, the present show can hardly hope to compete in popularity. It is, however, of considerable interest to the general engineer, and although we should hesitate to employ effusive terms in regard to it, we believe there are many items included which will repay a visit by the engineer.

The most striking feature of the Exhibition is undoubtedly the display of machine tools, in connection with which the stands of Sir W. G. Armstrong, Whitworth and Co., Schuchardt & Schutte, Ludw. Loewe & Co., Selig, Sonnenthal & Co., Joshua Heap & Co., C. W. Burton, Griffiths and Co., Buck & Hickman, Ltd., Charles Churchill & Co., and John Stirk & Sons are prominent with English, American and Continental productions. The last-named firm is noticeable as the only one showing electrically-driven tools in which the motor is actually incorporated with the tool, although, of course, motor-driving, in some form or other, is generally favoured.

Of steam engine building firms W. H. Allen, Son & Co., Willans & Robinson, with an exhibit of steel; the Thames Ironworks, Shipbuilding and Engineering Co., whose generating plant supplies electrical energy for driving the exhibits; and Easton and Bessemer, Ltd., are among those present.

The Stirling Boiler Co. and the Davies Patent Boiler, Ltd., represent the water-tube boiler industry, the latter firm's boiler supplying steam to the Exhibition. Green's economisers and McPhail & Simpson's superheaters are also well-known objects of engineering interest.

Other features of the show, which will attract attention, are suction gas producers and engines, pumping and ventilating machinery, roller bearings, steam fittings, scientific and drawing instruments, time recorders and checkers, &c.

An exhibit well worth close inspection is the Hele-Shaw clutch, which has already been adapted to the motor-car and for coupling motors up for electrical driving in factories; one or two steam wagons are also on view, including a 5-ton steam wagon with a portable electric plant, by Savage Bros., Ltd.

Electrical exhibitors are not by any means easy to find, but attention may be drawn to the stands of J. Richmond and Co., Simmonds Bros., the Simplex Steel Conduit Co. and F. A. Glover & Co., while it is of interest to note that the Chamberlain & Hookham meter (supplied by Venner and Co.) has been largely adopted on the various stands on which some of the best lighting effects are due to the use of Linolite.

We had almost forgotten to mention the very fine display of technical literature shown by the various engineering journals, among which will be noted the Electrical Review.

The above outline gives some idea of the engineering contents of the exhibition, which has an appropriate centre piece in Keith's patent electric motor and air circulator, an apparatus, the useful and ornamental effects of which will, no doubt, be much appreciated by the jaded Olympian.

W. H. Bailey & Co., Ltd.

This firm, who are manufacturers of all kinds of machines and fittings for moving and controlling liquids, exhibit a large variety of their well-known specialities.

Among the more interesting items is the Koster patent air compressor, which represents a marked improvement on the ordinary form of machine. It has a mechanically operated piston valve for admitting the air to the cylinder and only one outlet valve, the action of which is controlled by the piston valve. These compressors are exceedingly efficient, and can be run at high speeds, making them particularly suitable for driving by electro-motor; and two of these machines are so driven on the stand.

Another of the firm's specialities on view is the "Davidson" patent direct acting steam pump, which has a remarkable range of speed varying from 1 or 2 strokes to 200 or 300 strokes per minute.

Among the other pumps on view, the "Aqua-thruster," or Bailey's pulsating pump, is a very popular type of apparatus.

Many interesting types of valve are also exhibited, among which may be mentioned the "Foster" patent reducing valve, which is claimed to be the only spring controlled valve which will open from any degree to full bore, according to the demand made on it.

The "Bailey" patent "key-ring" renewable valve seat, which, when fitted in stop valves for high pressure superheated steam, allows for differences of expansion between the seat and body, and prevents steam leakage, is also on view.

The principle of the "key-ring" is the adoption of a flexible metallic connection between the seat and the body, similar in construction to the well-known Ramsbotton piston ring. A seat of the ordinary type is screwed into a spring ring, which is sprung into a groove in the valve body; the seat can be removed and replaced at any time.

The firm also exhibit an "Express" high speed boiler-feed pump, which will force water against a pressure of 200 lb. per sq. in., and deliver 8,400 gals. per hour, when running at the high speed of 250 R.P.M. This speed enables the pump to be driven very conveniently directly-coupled to the electro-motor or through one train of gear only. It is of the double-acting ram type, with one externally packed stuffing box, with the plunger passing through a sleeve.

This pump is fitted with the valves designed by Prof. Gutermuth. A valve is made out of one piece of sheet metal, weighing only a few ounces, and it is claimed for it that there is a full-way passage for the moving of the water, and no loss by friction through contraction, deflections or throttling. There is no practical speed at which the Gutermuth valves will fail to act with promptitude and certainty, and without wear and tear.

Holden & Brooke, Ltd.

This firm has achieved a household reputation, so to speak, in connection with the injector business, and the many patterns of this apparatus on view are quite representative of their efforts in this direction.

Among the principal types shown may be mentioned the single movement injectors, so well known for their simplicity, the exhaust steam type of injector which economically combines the functions of a feed pump and feed-water heater, and varieties of locomotive injectors.

Various other specialities include vacuum ejectors, water heaters, the "Expulsor" pulsating steam pump, an automatic vacuum discharge for clearing water, oil, &c, from separators and pipes under a vacuum, the action of which is clearly demonstrated by a working model fitted with a glass casing; the well-known "Sirius" and other steam traps suitable for pressures up to 300 lb. per sq. in., and Lernert's patent water meter, which is claimed to accurately measure by weight, and automatically record the quantity of water or other liquid passing, also figure on the stand.

Jessop & Appleby Bros. (London and Leicester), Ltd.

Messrs. Jessop & Appleby are numbered among our well-known crane builders, both for steam and electrical working; their exhibit at Olympia takes the form of a 5-ton portable steam crane of the type much favoured by contractors, and well known for its handy qualities.

John Stirk & Sons.

As indicated in our opening remarks, this is the only firm exhibiting the self-contained type of electrically driven tool, and the two examples on view, viz., a 6-in. slotting machine and an 8-in. high-speed lathe, are shown on Stand No. 16.

Of all classes of machine tools, none is better adapted for direct electric driving than the slotting machine. The machine illustrated

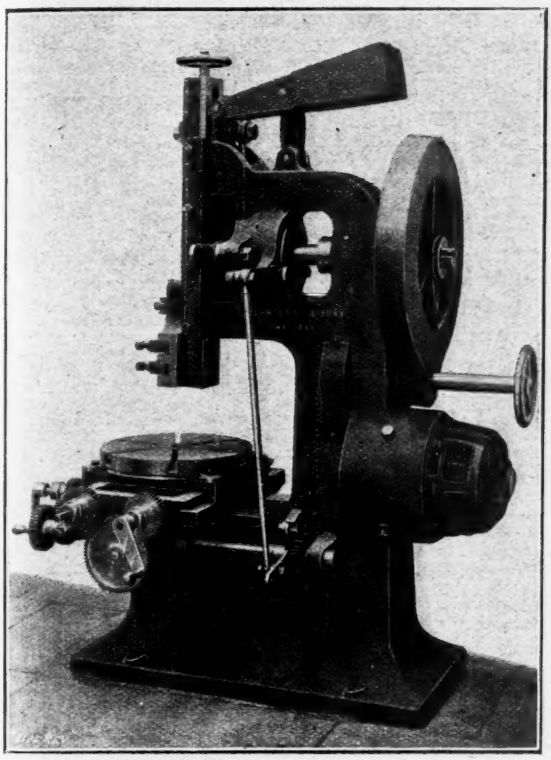


FIG. 1.—SELF-CONTAINED ELECTRICAL SLOTTER.

in fig. 1 is a standard 6-in. stroke slotter fitted with the firm's patent electric drive. The motor, of which the carcase forms part of the machine frame, is shunt-wound and gives 1½ H.P. at any speed between 500 and 1,500 R.P.M. A chain transmits the power to the pinion shaft, and a further reduction is accomplished by the usual gearing at the back of the machine. A total purchase of about 18 to 1 is provided, and this gives a suitable number of strokes per minute. As with a 6-in. machine, it is not to be supposed that a shorter stroke than 2 in. would ever be used, the range of speed provided in the motor is all that is required. The speed regulator is so marked that the operator can see at a glance what is the correct position of the controller arm for the work the machine is engaged upon, and the electrical equipment is of the highest grade.

The lathe which we illustrate in fig. 2 has its motor, a 7½-H.P. shunt-wound machine, combined with the box end, under the headstock; this construction gives exceptional rigidity and accomplishes a great saving in floor space. The motor speeds can be varied between 400 and 1,200 R.P.M., and power is transmitted by chain drive to the spindle.

The head stock gearing is of solid construction, and the four gear changes, giving respectively, 50, 75, 100 and 150 ft. per minute cutting speed, are operated by one handle.

The machine will deal with any diameter between 2¼ in. and 6¾ in., and the feed box provides for ⅛ in., 1/16 in., or 1/32 in. traverse.

The firm also specialises in a 30-in. boring and turning mill with a patent self-contained motor drive, the motor being arranged in much the same way as in the slotting machine. Bearing in mind the adaptability of this class of tool, and the possibility which it gives of running at the correct cutting speed, and so getting the utmost possible output from the machine, we feel sure that Messrs. Stirk's exhibit will be viewed with special interest.

The Temperley Transporter Co.

The Temperley Co., as at previous exhibitions, are represented by a series of working models of the distinctive types of their well-known transporter, which at the present time plays such an important part in the efficient handling of coal and other material at power stations, gas works, factories, wharves, &c.

The models include one of the Temperley patent grab transporter installed at the Bournemouth Gas and Water Co.'s works at Poole, Dorset, for discharging from the steamer or railway direct into the store; a travelling tower transporter, working with patent automatic dumping skips for discharging from a vessel; a portable transporter rigged on to a vessel's derrick and worked from the ship's own winch; also full-sized models of the company's patent traveller and grab.

Crosier, Stephens & Co.

Messrs. Crosier, Stephens & Co. are displaying a number of items of interest to engineers. These include sample ingots, sheets, rods and tubes of aluminium and its alloys, together with various joints for aluminium electrical conductors; the "Cromil" cupro silicon, which has proved a valuable agent in clarifying, refining, hardening and strengthening copper, gun-metal and brass castings, and the "Cromil" Acheson graphite paint, which has a special field of usefulness for protecting exposed steel and iron-work generally, such as occurs largely in connection with electric tramway, power station and general engineering work.

The firm are large suppliers of the Acheson graphite, which finds favour for paint making and lubricating, also as a filler for dry batteries, to which reference is made in our "Notes" columns.

A variety of small tools, including "Kramos" electric drills, "Cromil" spraying machines, &c., are also on view.

Mica Boiler Covering Co., Ltd.

This firm, who are, we believe, the only exhibitors of heat non-conducting coverings, show samples of their materials suitable for steam pipe and boiler work. These coverings are composed of mica flakes baked to a white heat in moulds of the required shape; the resulting covering is non-inflammable, non-corrosive, and absolutely insoluble in steam and water. Being applied in sections, it is removable for purposes of inspection and repair, and if comparative efficiency tests are of any value, those published by the company cannot fail to favourably impress the power station engineer.

The Stirling Boiler Co., Ltd.

This company's well-known type of boiler is demonstrated to the visitor by means of sectional and working models.

A feature of the company's manufactures, which, unfortunately, does not figure, either model or life size, on the stand, is the Stirling independently-fired superheater.

There is reason to believe that the independently-fired superheater is receiving considerable attention from the station engineer at the present time; and it is interesting to note that the company is building apparatus of this kind for the Shoreditch electrical department, and for the London Electric Supply Corporation, in each case capable of dealing with 80,000 lb. of steam per hour.

The Stirling superheater consists of two upper drums and one lower drum connected together by banks of tubes; the steam enters the rear top drum, passes down the back bank of tubes to the lower drum, and thence up the connecting bank of tubes to the front steam drum and outlet. In front of the superheater proper, however, is arranged a part Stirling boiler, consisting of an upper or steam drum connected to a mud drum by a bank of tubes. Circulation of this boiler portion is obtained by down-comers placed at the ends either in or outside of the brickwork in which the superheater is set. This boiler portion acts as a water seal on the superheater proper, and so serves to prevent an unduly high temperature obtaining which might injure the superheater should the supply of steam passing through the latter be suddenly reduced. The steam, which is generated in the boiler portion, is passed into the saturated steam side of the superheater, and so goes to add to the evaporative capacity of the plant.

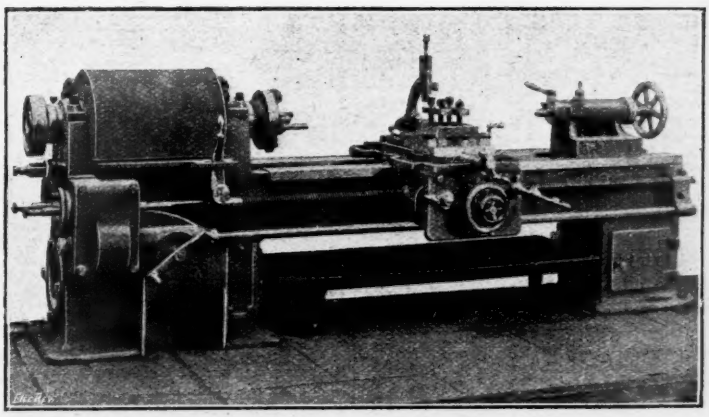


FIG. 2.—SELF-CONTAINED ELECTRICALLY-DRIVEN LATHE.

(To be continued.)

Sutton-in-Ashfield Lighting.—The B. of T. has deferred consideration of the question of revoking the E.L. order for another year.

E

THE DEVELOPMENTS OF WATER-POWER IN THE PROVINCE OF LIGURE, ITALY.

Among the societies which are springing up in all parts of Northern Italy, having for their object the development and application of water-power to factories, lighting, railways, &c., in the form of electrical energy, there now stands out quite prominently the Societa Idroelettrica Ligure, which is fortunate in having for its founder an able and resourceful engineer, in the person of Prof. Zunini, of the University of Milan, and for its supporters several Italian financiers of note. It commands respect and interest also from the ingenuity of the method of cheapening the hydraulic engineering connected with the schemes.

At the Milan Exhibition this society has an exhibit of very great interest. A huge model in relief shows the whole of the district from the French border eastwards over the whole water-shed of the Po River, while a large collection of hydraulic diagrams and statistics on rainfall and the flow of rivers is exhibited.

In addition, preliminary calculations of the cost of the various schemes devised by this society, some of which are already in course of construction, are exhibited on the walls of the building.

In this connection, it should be noted that in Italy coal is very expensive, ranging from 35 fr. to 45 fr. per ton, and that finding herself almost entirely dependent on water for economical power production, Italy has recently devoted much attention to the cheapening of that most expensive item, the hydraulic engineering.

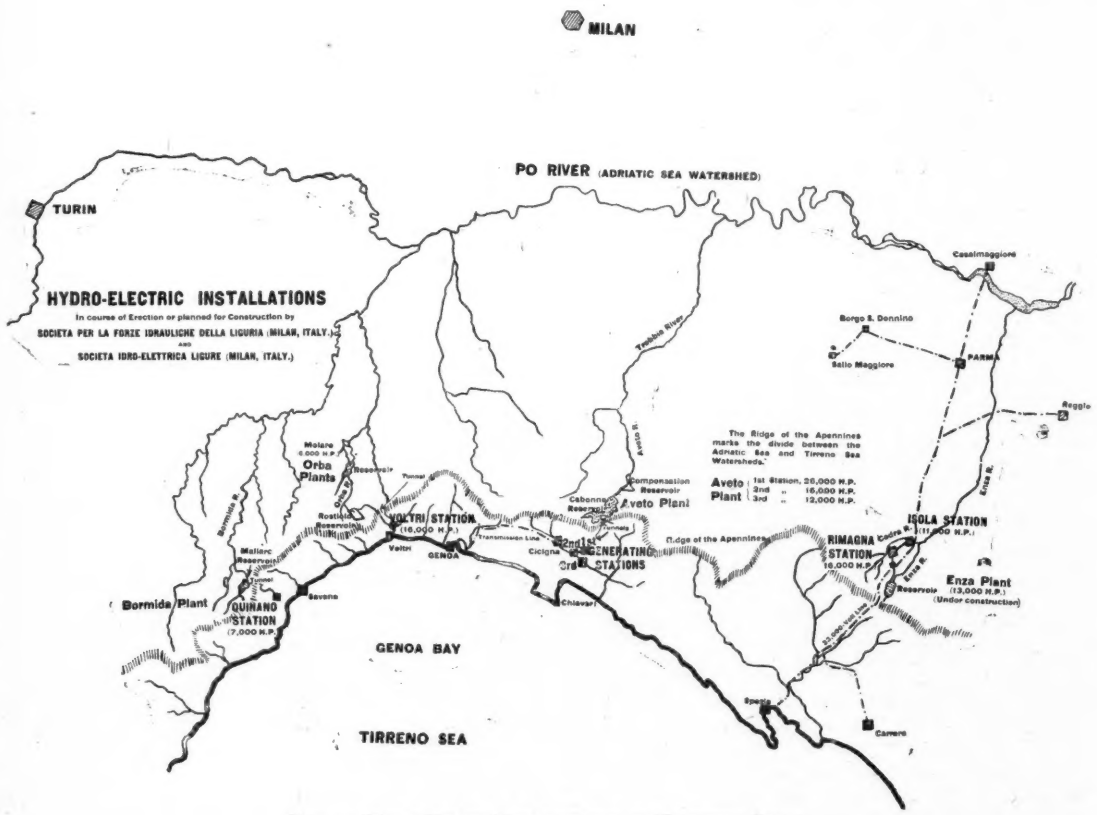
Referring to the accompanying map, which shows the Bay of Genoa and indicates the Appenine mountains, we should note that the ridge of the mountains marks the divide between the Adriatic Sea and the Tirreno Sea water-sheds. It is obvious that almost all of the water-shed formed by these mountains drains to the northward, falling slowly down the long and gentle slope to the valley of the River Po. On the south of these mountains, however, the fall is very sudden and quick from the mountain peaks to the sea level.

Hydro-electric power plants built on the northern slope have to cover a large stretch of country before any appreciable difference in altitude is obtained, while if the lakes and streams be dammed up on the northern side and then diverted, or even, as is to be done in some cases, tunnelled through to the southern side, far more conveniently arranged and less expensive plants may be built.

It was the intention of the Societa Idroelettrica Ligure to use this system for all of its power schemes, viz., the Bormida, the Orba inferior and the Orba superior, the Aveto and the Enza or Isola plants.

In the case of the last-mentioned plant, however, the various villages and cities on the Enza River, which drains the watershed which the society wished to use, refused the necessary permission to divert the flow of this water to the southern side of the Appenines.

The capacities of the various plants are as follows :—Bormida, 7,000 H.P., situated 53 km. west of Genoa ; Orba inferior, 6,000 H.P., having a power station at Molare, 46 km. from Genoa, to the north west ; Orba superior, 16,000 H.P., 15 km. to the west of Genoa ; Aveto, 54,000 H.P., having a power station at Cicigna, 35 km. east of Genoa ; Enza or Isola plant, 26,000 H.P., situated 45 km. to the north of Spezia, on the Mediterranean coast (see map).



Map of Water-Power Developments in Northern Italy.

Reference to the map shows the Aveto River flowing into the Po and having its source near Cabanne, where a lake will be formed with a capacity of 54,000,000 cb. metres, by erecting a dam 44 m. high at the north-eastern end. A compensation reservoir is being built to catch the flood water and to provide for a continuous flow down the old water course of the Aveto of 2,500 litres per minute, this being double the present observed minimum. The capacity of this reservoir will be 10,000,000 cb. metres. From the main reservoir at Cabanne a water course 9 km. long is being con-

This large undertaking is exciting much attention in Northern Italy, and the following details of one or two of the plants will be of great interest, if only for their ingenuity, when considered as hydraulic developments.

structed, one half of which will be in canal and the other half in tunnel. From this channel a continuous flow of 2½ cb. metres per second as a minimum quantity may be drawn, with a peak load allowance of 7 cb. metres per second. The various water flows considered throughout the whole scheme have been checked by examination of meteorological observations extending over the last 70 years, and by more close personal study on behalf of the Society's hydraulic staff since 1903.

The head of water dealt with is so great that it has been divided between three stations, the first two to be used by the Society, and the power from the third station to be given to the railway administration of Italy, in accordance with Italian law, if claimed by it within two years of the granting of the rights.

The first generating station has a water-head of 350 metres, and will have 8 units of 3,500 H.P. each installed. The second generating station will have a head of 190 metres, and a final output of 17,500 H.P. divided between five generating units. The third station, the development of which is left to the railway administration, will have a head of 170 metres, and a total output of 12,000 H.P.

It is estimated that the total amount of energy drawn from the first and second stations will be 60,000,000 KW.-hours per annum, and from the third station 20,000,000 KW.-hours per annum. The cost of the first and second stations is estimated at 16,000,000 fr., and it is estimated that energy may be produced for 2½ centesimi per KW.-hour, and, it is hoped, may be sold to the average customer for 5 centesimi (= ·5d.) per KW.-hour. The division of cost is as follows:—

DIVISION OF COST.

Purchase of land	2,000,000 fr.
Rebuilding of roads, schools, churches and houses	1,000,000 fr.
Compensating reservoir and accessories ...	1,500,000 fr.
Power reservoir and watercourse, including tunnels, sluices, gates, penstocks, &c. ...	4,000,000 fr.
Pipe lines	1,500,000 fr.
Masonry for power houses	800,000 fr.
Hydraulic machinery...	500,000 fr.
Electric machinery, including switchboards, generators, and step-up transformers ...	1,500,000 fr.
Transmission line	1,700,000 fr.
Step-down transformers and secondary distribution	1,500,000 fr.
Giving a grand total of	16,000,000 fr.

The transmission lines will employ a voltage of 33,000, and will be approximately 30 km. long, supplying power chiefly to the city of Genoa.

The Enza or Isola Plant.—This plant has a capital of 2,500,000 fr., now to be raised to 4,000,000 fr., and the hydraulic and civil engineering has already begun. It takes water from the Enza River (see map), where a reservoir of 4,000,000 cb. metres is being built.

An "earth" dam 20 metres high will form the barrier thrown across the river, which in itself is a daring piece of civil engineering, and one which, if successful, will lead to great cheapening of future hydraulic work.

The water from this reservoir is taken by a watercourse 5 km. long to the Rimagna, or first station, producing a fall of 200 m. with ·4 cb. metre per second, realising 1,600 H.P.

The tail race at this point enters the water-course of the Cedra River, which brings a continuous flow of ·5 cb. metre per second, and it has already been led to this point by a canal 5 km. long. From this point the combined flow of ·9 cb. metre per second is carried by another canal 5 km. long to a head reservoir, with a capacity of 35,000 cb. metres, and from here a pipe line 350 metres high descends to the second station, or Isola plant, where Pelton wheels and alternators are used for the development of 11,000 H.P. The average speed of water in the pipes will be 7 ft. per second. The generators at these stations are being built for 5,000 volts, which will be stepped up to 33,000 volts by transformers supplied by the Gadda Co., of Milan. The power is conveyed by a 50-km. line to the town of Spezia and neighbourhood on the south, and also on the north by a line 60 km. long, to the city of Parma and neighbourhood; the total length of line will be 200 km., and the frequency 42 cycles per second.

The other power systems which are being undertaken by this society are very similar in plan, and details are, perhaps, unnecessary.

In the Aveto scheme alone it will be noticed that 1,000,000 fr. are allowed for the rebuilding of roads, schools, churches, &c., since this scheme involves the entire submersion of two villages, and the changes in the face of the country dealt with by these schemes are so great that it is stated that one of the most serious items of expense up to the present has been in the department superintending the purchase of land and the obtaining of the necessary powers.

There remains, however, from even a slight study of the plans undertaken by the Societa per le Forze Idrauliche della Liguria an impression of great respect for the ability and daring of the Italian engineer and his financial supporters.

MUNICIPAL TRAMWAYS ASSOCIATION.

THE fifth annual conference of this Association was opened at Leeds on Wednesday. After the members had been welcomed by the Lord Mayor, the president (Mr. J. B. Hamilton, general manager of the City Tramways), delivered his address, which we abstract below. Thanks were accorded for this address on the motion of Bailie McFarlane, of Glasgow. The first paper read was that of Councillor Smithson on "Municipal Operation of Tramways," and it was followed by a discussion, in which Councillor Flint of Leicester, Alderman Hey of Halifax, Councillor Booth of Reading, Bailie McFarlane, Sir Baxter Ellis of Newcastle, Mr. Littler of West Ham, and others took part.

"Car Brakes" was the subject of a paper read by Mr. Mozley. This we also abstract. The discussion which followed was of a very warm description, the author's findings being subjected to considerable criticism. Mr. A. L. C. Fell, of the L.C.C. Tramways, was among the speakers. Our report of the discussion will appear next week.

Presidential Address.

Mr. Hamilton first referred to the great loss which the Association and all the members of it had sustained by the sudden death of Charles Revill Bellamy, who was general manager of the Liverpool Corporation Tramways, and the second President of the Association in the year 1903-4. Mr. Bellamy was one of the principal founders of the Association, and throughout his all too brief connection with it was to the front in everything which made for its growth and greater usefulness.

Many important matters dealing with Parliamentary legislation and Board of Trade and other Government Departmental regulations had been dealt with by the Executive Committee during the year. Amongst others, the regulation proposed by the Home Office in regard to locomotives in factories required a considerable amount of attention. The Executive Committee took this matter up on behalf of this Association as well as the Light Railways Association, and a clause was inserted which gave immunity to tramway depôts.

Numerous interviews had from time to time, through the courtesy of the Secretary of the Board of Trade, been permitted with the officers of that department. At these interviews the Committee had been enabled to lay before the Board their views upon details of construction and equipment of new lines, permanent way, &c.

The Committee had also been able to come to an arrangement with the Post Office Department as to the cost of guard wires in cases where telegraph or telephone wires were put up in proximity to previously existing tramway wires. In such cases the Post Office Department would pay half the cost of construction.

In all these matters the Association had had the active co-operation of the Tramways and Light Railways Association, and the Tramways and Light Railway Officials' Association, whose interests were identical with their own.

The tramways industry was growing very rapidly, and unceasing vigilance ought to be exercised to guard against repressive or harassing legislation or regulations. During the Parliamentary Committee Sessions, attempts were continually being made to introduce into Tramway Orders and Bills clauses which were not in their best interests, and these, when established, were quoted as precedents. To enable them effectually to protect themselves from such attacks, he thought the time had come when they ought to concentrate the whole of the tramway interest into one Tramways Association of Great Britain and Ireland, so that they might stand with a united front to all opponents. The effect of such a Union when presenting their case would be incalculably greater than in appearing as three different Associations representing presumably three different sets of interests, and, after all, their interests for all practical purposes were identical.

For the last year the Board of Trade Returns showed that, roughly, 33 million pounds had been expended by local authorities in tramway undertakings. This showed an increase of about five millions for the year. The number of miles open was 1,395, and

the number of undertakings 174. Of this number, 115 were municipally operated, the capital expenditure being about 28½ millions. The gross receipts for the whole of the municipally operated undertakings were about 6 millions, whilst the number of passengers carried at about 1d. per head was 1,355 millions, an increase for the year of 160½ millions. Combining municipally owned and operated tramways and company tramways, there was a total capital outlay of 52¾ millions, the miles of line in operation were 2,116, the total gross receipts amounted to 10 millions, and the passengers carried reached the huge total of 2,068 millions.

In his opinion the petrol omnibus was yet far from being a sure and reliable conveyance—which was the first requisite of such a service—or comparable in point of operating cost with an electric car. In London the most fortunate companies had a maximum of about 70 per cent. of their total stock on the road at any time, whilst many of them had only between 50 and 60 per cent. He was quite sure that on the most level and easily worked routes, when thorough normal maintenance was carried out and sufficient depreciation allowed, the expenses per bus-mile were but little under 1s. It was almost impossible to compare these results with those of an electric tramway, which cost, including sinking fund, depreciation and renewals, practically about 7½d. per mile to run, because, in addition to the saving per mile run, there was the much greater attraction for traffic owing to greater reliability, the greater carrying power of each vehicle—56 as against 36 or 38—and the fact that an immense saving occurred in other departments of the Corporation as a result of the maintenance of a large proportion of the highway in the principal streets by the Tramways Department.

Unless a very great improvement in reliability and economy of operation took place, he did not think motor-omnibuses would long retard, even in London, the extension of tramway enterprise.

During the last few months there had seemed to be quite an epidemic of serious accidents through tramway cars running away downhill. The two principal accidents which had occurred—at Highbury, London, and at Halifax—were under quite dissimilar conditions: in one case the gradient was 1 in 22, and in the other a very acute one of 1 in 11. On both cars were brakes acting on the rails in addition to the ordinary hand brake acting on the wheels. The evidence at the Board of Trade inquiry elicited the fact that both accidents were due to an error of judgment and to over-confidence on the part of the motorman, who allowed too high a speed to be attained before applying the track brake.

Whatever brake might be in operation must depend for its use on the judgment of the motorman in charge, and it was in just this variable human quantity that the greatest likelihood of failure lay.

That the operation of tramways was being conducted with every regard for the safety of the passengers and the public generally, was gradually being recognised by the Board of Trade, who during the past year had granted to many tramway undertakings increased maximum rates of speed.

The conveyance of heavy goods traffic upon tramways had scarcely yet engaged the serious attention of many of the municipal undertakings. He believed that goods haulage between railway termini and factories and warehouses, and in other directions, offered a great field for development. In Leeds they had lately contracted, in connection with another Corporation department, to carry some 100,000 tons of material during two years for about 3 or 4 miles. It was estimated that a saving of from £2,500 to £3,000 to the city would ensue. Should this be successful, he was certain they would be able to carry out a lot of other work in a manner satisfactory to the public and to themselves as goods carriers to and from stations.

The President congratulated the Corporations of Bradford and Manchester upon their courage in commencing very extensive parcel services. Preparations had been made to carry out the work on a very large scale; although in their case the financial results had been adverse so far, still it was a business which he trusted would grow, and become in time self-supporting, if not profit-earning.

During the past year several cases had occurred in which the employés had thought it necessary to withdraw their labour so as to get redress for their grievances or compliance with their requests as to wages, &c., and great loss and inconvenience resulted to all classes of the community in the districts concerned. Surely such obsolete and drastic remedies could be avoided by fair and impartial arbitration. It was gratifying to observe that this most sensible course was actually adopted successfully by one of the large corporations this year.

He thought the great weight and influence of an Association such as this should be readily given towards facilitating arbitration being accepted in all cases where questions arose which required settlement.

Car Brakes.

By Mr. Henry Mozley, General Manager, Burnley Corporation Tramways.

(Abstract of paper read before the Municipal Tramways Association, *September 19th, 1906.)*

In view of the large number of accidents on tramways recently owing to the failure of brakes, and the anxiety of the Executive Committee to have the question considered in all its bearings, I had no hesitation in complying with the request to give the Association the benefit of our experience with brakes at Burnley, and my Committee instructed me to furnish you with any information you required.

The Burnley Corporation Tramways consist of a trunk line 7 miles 12 chains in length, and three branch lines a little more than one mile each.

The trunk line has been worked electrically from March, 1902. The cars are double-decked bogies, equipped with Brill maximum traction trucks and B.T.-H. motors, their weight being 12 tons 10 cwt. and seating capacity 70, the weight fully loaded 17 tons 10 cwt., with occasionally heavier loads. There have been no accidents connected with brakes, which are the simple hand-brake improved by ourselves, and the rheostatic brake. Track brakes are not required or used on this route.

The Manchester Road branch is of an exceptionally dangerous character, having a continuous gradient averaging 1 in 18 for the full distance, and 1 in 9·8, 11, and 12 in parts near the junction with the trunk line, the actual rise being 340 ft. in 1 mile 13 chains.

The car for this and the Townley route is of special design, having a large inside seating capacity (44), the Townley branch having a low culvert under the Leeds and Liverpool Canal. This necessitated four motors, thus bringing up the weight of the car to 14 tons 12 cwt. 1 qr. 26 lb. empty and 17 tons 10 cwt. 3 qrs. 26 lb. fully loaded.

To control this weight on such heavy gradients the best brakes obtainable were necessary, and my Committee appointed a special sub-committee to deal with the question.

We had come to the conclusion that only mechanical track brakes were suitable, and made full inquiries into all types of track brakes known to tramway men, including the Hewitt and Rhodes air brake erected on cars at Oldham (this brake was used for emergencies only, and appeared to be too unreliable in the matter of maintenance), and found not one would answer our requirements. We were, therefore, driven to the necessity of designing one.

It was found that it would be unsafe to use wood for the slippers, and that soft grey cast-iron was the only suitable and safe material.

I propose to go into a little more detail to make clear to you the causes which proved to us the unsuitableness of the magnetic and the adoption of the mechanical track brakes with cast-iron slippers in place of wood—the general practice where mechanical track brakes are used.

We obtained permission to try two rival magnetic brakes for the purpose of ascertaining their suitability for service brakes, and, at the same time, to ascertain whether the brake could be used on the Manchester road cars.

We had gained considerable experience of the rheostatic brake, and found that it was highly destructive to the motors, and could only be used for emergencies. The magnetic brake being actuated by the same means, we took the precaution of requiring the makers to satisfy us by actual measurements as to the voltage and amperes generated by the motors.

The Newell brake was fixed to No. 6 car, but we could not use it as a service brake owing to the high current generated causing the

Pole No.	Distance. Feet.	Grade.	Brake.	Time. m. s.	Speed.	Average amps.	Average volts.	Remarks.
101—84	1,856	1 in 26	B.T.-H.	1 47½	11·75	13·4	135	Car brought to a stop with B.T.-H. brake, 82 amps. maximum current.
		1 in 28	—	—	—	—	—	
		1 in 22	—	—	—	—	—	
		1 in 40	West.	1 47	11·80	19·2	198	
		1 in 253	—	—	—	—	—	
73—65	857	1 in 26	B.T.-H.	0 46·4	12·6	16·0	204	Dead stop made with 85 amps. maximum
			West.	0 49	11·9	16·0	146	B.T.-H. brake and 100 amps. + West.
49—46	328	1 in 18	B.T.-H.	0 17	13·1	28·0	326	West. Resistance smoking, stop made with
			B.T.-H.	0 12·8	17·4	47·0	584	100 amps. + B.T.-H. brake, and 100
			West.	0 11·8	18·9	51·5	710	amps. + West. brake. West. wheels skid; B.T.-H. very slightly.
37—34	351	1 in 21	B.T.-H.	0 15·5	15·45	35·0	453	Dead stop, no skid, 100 amps. B.T.-H.
			B.T.-H.	0 16·6	14·4	30·0	386	and West.
			West.	0 16·0	14 95	40·0	532	

resistances to overheat, its tendency to skid the wheels and other causes.

The British Thomson-Houston Co.'s brake was kept in service five months, and during that time three armatures were burnt out, and the brake had to be abandoned.

Tests were made on December 22nd, 1903, and were carried out on certain down grades on the tramway route, as indicated by pole numbers in the table on the previous page.

During the tests these grades were approached at a fairly high rate of speed, and shortly before reaching the first pole marking the prescribed course the track brakes were applied. The time required to cover the distance was noted, and concurrent readings were taken of amperes and volts at intervals of four or five seconds. From these observations was determined the average speed of car when descending the grade under the action of the brake, also the average total amperes generated by the motors, and the voltage across the motor armature. The rails were very greasy.

In the table on p. 456 the average values of amperes and volts are computed from the readings taken when running between poles indicated in first column. The momentary high values observed when bringing car to a stop have *not* been considered in computing the average.

Several emergency stops were made on slight down grade with the following results:—

Brake.	Distance to stop.	Time. Seconds.	Volts.	Remarks.
B.T.-H.	67 ft.	5	640	With West. brake motors flash and wheels skidded slightly. No flashing or skidding with B.T.-H. brake.
B.T.-H.	54 ft.	4	320	
West.	130 ft.	7	1,160	

The second emergency stop with B.T.-H. brake was an entirely satisfactory stop, the retardation being practically constant, and at a very high rate. The above figures show the rate to have been 4·6 M.P.H. per second, and the initial speed about 18·5 M.P.H.

A further series of tests was made with the same cars on the Manchester Road route. The cars were allowed to descend the grade with the track brakes in operation. Five stops were made during the run, using track brakes only, and the time from start to finish of test was noted in each case, as well as approximate speeds and total amperes taken by the brakes:—

	B.T.-H. brake.	West. brake.
Average speed, approximate ...	7½ M.P.H.	7½ M.P.H.
Total time including stops ...	14 min.	12 min. 7 sec.
Total time exclusive of stops ...	11 min.	10 min. 42 sec.
Average current exclusive of momentary stopping currents over 50 amps.	16·68 amps.	19·29 amps.
Average current inclusive of stopping currents	23·22 amps.	29·28 amps.

Although the B.T.-H. readings were more favourable than in the first test, the voltage and amperes were still high.

Now compare the ordinary braking currents with the driving currents on the same hills:—

Brakes	10 to 68 amperes.
Driving	51 to 90 „

Remembering that motors are designed for driving only, it is no mystery why armatures burnt out with the almost double work put upon them.

But this is not the only reason why magnetic brakes could not be used for service purposes—they are uncertain in their action, and the tendency to skid is a source of danger.

With every desire to obtain a service brake, we were obliged to give up the magnetic brake, and we are still on the look-out for a suitable form of mechanical brake to relieve the driver from hand braking.

The magnetic brake had not been used anywhere under the circumstances of Manchester Road tramway, and with our experience of it on the trunk line it was quite clearly an unsuitable brake for the conditions obtaining there. By experiment it has been found that at saturation point the Newell brake magnet can be lifted from the rail at 15 cwt. Compare this with the weight required to hold 18 tons on 1 in 9·8—the car must run away if it has nothing else to depend on.

I now proceed to describe the mechanical track brake, and the way it operates upon the cars which have been working the Manchester Road route for a period of 2½ years with an entire absence of accident.

The hand-wheel of the track brake has a diameter of 16 in.—reckoning 15 in. centre of rim gives a circumference of 47 in. This wheel operates a screw of ½ in. pitch (provided with a ball thrust to reduce friction), which is connected by pull rods direct to the swing lever in the centre of the car.

The gear ratio between the hand-wheel and the nut on the screw is 94 to 1. The floating lever in the centre of the car has a leverage of 5 to 3. The connection between this lever and the levers on the trucks is by rod and chain, and is not affected by the radial movements of the trucks on curves. The power is imparted to the track shoes by means of levers having a ratio of 3 to 1. Total leverage, 468 to 1.

The wearing parts of the shoes are of cast-iron, and are easily renewed.

The brake is used as follows:—On leaving the terminus at the summit the brake is screwed down sufficiently to allow the car to run at the proper speed with the hand-brakes off; the car is then controlled by the hand-brake, which has about the same leverage as the track brake. When the car is stopped, the track brake is eased off to allow the car to start, and then screwed down again as before.

For an emergency stop the rheostatic brake is used; its effect is very efficient, and will stop the car at 6 M.P.H. on 1 in 9·8 in 3 or 4 yards.

Each shoe and lever to the shoe is independent, therefore the failure of one shoe or lever does not affect the remainder. Two shoes only will safely control the car.

The track brake alone will bring the car down safely and make service stops, thus being a perfectly independent brake and additional to the ordinary equipment of the car. The shoes are easily changed, and last from 10 to 21 days according to the weather. The dimensions of the shoes are 15 in. long × 3 in. wide, and the wearing depth is 1⅜ in.

When cast-iron slippers were adopted there were no data available as to the wearing effect upon the rail, but sections of the rails on the heaviest portion of the gradient clearly show that the wear on the down or braking side is less than on the up or driving side, after 2½ years' service, and the passage of 81,655 cars.

Practically no sand is used on the down rail, even in greasy weather. The meteorological conditions of Burnley are bad, the rainfall being greater than in any other part of Lancashire except the Lake District; moreover, the subsoil is clay, which accounts for Burnley being such a favourable district for weaving.

The brake has recently been adapted to maximum traction trucks under the double-deck cars with equally satisfactory results.

Finally, I submit the following conclusions from our experience:—

1. Bogie cars are easier to control on steep inclines than four-wheel cars, whatever the character of the brakes.

2. Magnetic brakes, particularly those which affect the wheel brakes, are unsuitable for tramways either for service or safety purposes. They can only be considered as auxiliary to the rheostatic brake, and not as independent track brakes. They are highly destructive to the motors. They are treacherous and uncertain in their action.

3. The only forms of brakes which will safely control a car on gradients greater than 1 in 14 or 15, are:—

(*a*) Hand brake with adequate leverage actuating cast-iron blocks on the wheels.

(*b*) Mechanical track brake with adequate leverage provided with cast-iron slippers.

(*c*) Rheostatic brake for emergencies only.

BUSINESS NOTES.

Dry Batteries.—In connection with the Olympian exhibit of Messrs. Crosier, Stephens & Co., of Newcastle-on-Tyne, it is of interest to note that the firm are sole agents for Great Britain for the International Acheson Graphite Co., of Niagara Falls.

This graphite is the result of numerous experiments on carbonaceous materials, which led up to the use of anthracite coal as the most suitable material for conversion in the electrical furnace. The temperature obtained in the furnace is very high, and results in the decomposition and dissipation of the bulk of the impurities, which, for commercial purposes, usually amount to from 1 to 10 per cent. of the product.

The electrical conductivity of Acheson graphite is comparatively high; the resistance of 1 cb. in. having been determined as ·000320 ohm. We have had the opportunity of inspecting samples of the material, grade "Ba—2" 93 per cent. purity, and grade "Bb—1" 98 per cent., which is the quality chiefly used for filling dry batteries, and as such is employed by several leading makers. The choice of a filler for this purpose is of the utmost importance, as the efficiency of the cell depends primarily upon the use of a suitable material. The ideal filler is a material of great purity, possessing high electrical conductivity, wholly inert towards the solution acting as electrolyte, and capable of absorbing a maximum quantity of this liquid. It should also be wholly unaffected by the reactions taking place at the anode and cathode. Acheson graphite obviously meets these requirements, and it is superior to amorphous carbon on account of its greater purity and higher conductivity, while natural graphite of a similar quality would be altogether prohibitive in cost.

Brown, Boveri & Co.: A Month's Contracts.—As illustrating the continued popularity of the Brown, Boveri turbine machinery in Continental countries, we have been informed by Brown, Boveri & Co., Ltd., that orders have been secured during the month of August alone for 30,000 kw. of turbo-generators, the average size being about 1,800 kw. Messrs. Brown, Boveri have going through their works at the present time no fewer than 13 sets of over 5,000 kw. individual output, including several turbo-alternators of 7,500 kw., and, on the other hand, half-a-dozen turbo-dynamos (single armature) of 1,000 to 1,500 kw. individual output.

New Zealand.—The New Zealand Customs authorities have recently given a decision to the effect that electric radiators are to be classified as "hardware," the duty being 20 per cent. *ad valorem*.

Consular Notes.—Brazil.—The British Consul at Rio de Janeiro, in a report just issued, gives some details with reference to the Rio de Janeiro Tramway, Light and Power Co., Ltd., which was incorporated in 1904 under the provisions of the Canadian Companies Act, the head office being in Toronto. The capital consists of $25,000,000 share capital, and $25,000,000 debentures. The company was organised by a group of Canadian and American capitalists, most of whom are associated with similar enterprises in Canada and the United States, including the Sao Paulo Tramway, Light and Power Co., the Mexican Light and Power Co., Trinidad Electric Co., and the Montreal Light, Heat and Power Co., &c. The scheme of the company includes the development of water power and its utilisation in the form of electric energy in Rio de Janeiro and other places. The company has already acquired two large water powers, one of which is on the Parahyba river, a distance of about 80 miles from Rio de Janeiro, capable of producing about 100,000 h.p., others on the Rio das Lages, and streams in the vicinity, about 50 miles from Rio de Janeiro, where the company is now developing 40,000 h.p. This can be increased to 100,000 h.p. as the demand develops. The company expects to commence the distribution of electrical energy in Rio de Janeiro and the adjoining city of Nitheroy about the end of the current year. It is believed by the company that the present demand for power will be greatly increased as the advantages of the use of electric power become fully demonstrated. The company has acquired the Carris Urbanos, Sao Christorao and Villa Isabel Street Car Companies, and has also a large interest in the Carioca Co., which works the electric line from the centre of the city to the district of Santa Thereza. These comprise all the street car companies in Rio de Janeiro other than the Jardini Botanic Co., which operates in a separate zone. The Carris Urbanos and Sao Christorao Companies have animal traction. Prior to the acquisition of the Villa Isabel Co. the electrification of its lines had been commenced, and the same are now to be operated electrically. It is the intention of the new company to shortly commence the transformation of the rest of the system, which, it is expected, will be completed within two years. The Carris Urbanos, Sao Christorao and Villa Izabel Companies have now 125 miles of track, which will be increased in the transformation. The concessions of these companies vary from 30 to 50 years, with monopoly of zone. The new company is applying for a new concession unifying all the existing ones. The company has also acquired the Federal concessions for the railways to Tijuca and Corcovado, the former being already worked by electric traction and the latter by steam. The Corcovado Railway will shortly be equipped for electric traction. The company has also acquired the Société Anonyme du Gaz de Rio de Janeiro which, under its concession from the Federal Government, controls the illumination of the city until the year 1945. At present there is a small amount of electric lighting from steam plants belonging to the company; various modifications are to be made in the existing concession. The company has also a concession from the Municipality of Rio de Janeiro, which includes a monopoly for the distribution of electrical energy for power purposes until 1915, after which date the concession continues for a long period without monopoly. The company has recently acquired the telephone company, the business of which has heretofore been conducted by a German company. The telephone concession includes a monopoly for a period of 30 years. The installation, which was recently destroyed by fire, has just been completely renewed.

Army Contracts.—Manufacturers who wish to be on the list for tendering for Army requirements should read a notice appearing in our middle advertisement pages to-day.

Catalogues Wanted.—Messrs. Nursey & Marr, 19, Waterloo Street, Glasgow, invite manufacturers of electrical appliances and materials to forward price lists and catalogues.

H. & B. Lifeguards.—Messrs. Hudson & Bowring, Ltd., of Manchester, have recently received the following orders for lifeguards:—Ten sets for Rangoon, nine for the Wemyss and district light railway, nine for the Jarrow tramways, twenty for Damas tramways, six for Kimberley, and repeat orders for Gosport and Fareham, Leith and Rochdale. The same company has also received orders for patent Tetrad ears from the Birmingham, Warrington and Salford Corporations.

The English Concession at Lisbon.—A Lisbon correspondent states that the New Lisbon Elevator Co. (Nova Companhia dos Ascensores Mechanicos de Lisboa) has addressed a petition to the Government in regard to the agreement concluded between the City of Lisbon and the former Companhia Carris de Ferro, whose concession was subsequently transferred to the Lisbon Electric Tramways, Ltd. The elevator company alleges that after the agreement was completed with the sanction of the Government, certain unlawful alterations were made which converted the concession granted to the company into a monopoly. Although the Government has not yet expressed any action in regard to the petition, the City Council has appointed a committee to investigate the matter. The correspondent adds that no opinion can yet be formed as to whether the complaint has any justification, or whether the question is a subtlety arising from the problem of competition in Lisbon.

Picture Cards for Electricity Consumers.—A good deal has appeared in our columns lately, and more will appear shortly, on pushing the sale of electricity. We have now received a packet of Rockley's electrical postcards (published by Messrs. J. Curwen & Sons, Ltd., of Berners Street, W.), which have a special interest in this connection. These cards (Series I) have been produced with the object of appealing to the prospective consumer of electricity, and perhaps of retaining the old customer too, by bringing graphically home to them the great advantages to be obtained by the use of electricity for lighting in private houses. Later series will doubtless appeal to other classes of consumers. The cards are designed and worded by Mr. C. Rockley, who has had a good deal of publicity department experience in electricity supply at West Ham. Each card in the series presses home tersely some different claim that the electrical man makes for his commodity, it being intended that the supply authority should send them out as a six months' educational course at the rate of one per month. In our view there is just enough on each card to catch the interest and drive home one truth. There is sure to be a good deal of this sort of thing done in the near future, and we can imagine that with some classes of the public it may be more successful, while also less costly, than distributing publicity journals, the cost of producing which contractors and others have to bear by giving advertisements.

Trade Announcements.—Mr. Alex. M. Fyfe, 74, York Street, Glasgow, has assumed as a partner Mr. R. M. Wilson (lately manager with Messrs. J. Kilpatrick & Son, electrical engineers, Paisley). The new firm will be called Fyfe, Wilson & Co., and will carry on business as agents and merchants for electrical, mining and mechanical machinery and accessories at the above address.

Messrs. Jay, Broll & Co., 31, Old Queen Street, Westminster, have been appointed London managers to the Asbestos Fireproof Paint Co., Ltd., of Birmingham.

The Crypto Electrical Co. announce that, owing to the large increase in their business, they have been compelled to move to larger premises at 155 and 157, Bermondsey Street, London, S.E.

Messrs. Kolben & Co., Ltd., are notifying electrical men to the effect that on June 30th last their connection with Messrs. Witting, Eborall & Co., Ltd. (late of Temple Bar House, Fleet Street, E.C.) came to an end. They have now taken offices at 20, Budge Row, Cannon Street, E.C., and commenced trading in their own name. Mr. A. S. Herbert, who has lately been carrying out work for Messrs. Kolben in Australia, is now their engineer and manager for Great Britain and the Colonies. As in the past, their chief classes of work will consist of high tension transmission, water-power schemes, turbo-dynamos and generators, direct-current plant, single and polyphase plant, water turbines and Pelton wheels. They are also prepared to design and construct machines to clients' own wishes and requirements, their works being specially adapted for doing this economically.

Messrs. Monte Callow & Co. notify that from September 20th, their office and stores address will be Orwell House, Ipswich.

Messrs. John Yates & Co., Ltd., of Aston Manor, have secured the services of Mr. Thomas Vickers, of Sheffield, who for many years has been engaged in the manufacturing and selling of all kinds of tools and plant used by railway, tramway, and public works contractors, for their contract department. Mr. Vickers will take up his residence in Birmingham. Mr. Bramball, owing to ill-health, has found it necessary to resign his position with the firm, and is taking a sea voyage abroad to recoup.

Stirling Boiler Contracts.—Amongst other important orders recently obtained by the Stirling Boiler Co., Ltd., of Motherwell, are the following:—

Colwyn Bay U.D.C. Electricity Works.—One boiler of 2,760 sq. ft. heating surface.

Walsall Borough Electricity Department.—One boiler of 3,450 sq. ft. heating surface.

London Electric Supply Corporation.—One Stirling independently fired superheater, capable of superheating 80,000 lb. of steam per hour, fired by chain-grate stoker, for their Deptford power station.

Sydney Municipal Council (New South Wales).—Four boilers each of 5,750 sq. ft. heating surface, with superheaters, chain-grate stokers, ladders, gangways, piping, &c.

Catalogues and Lists.—Messrs. Babcock & Wilcox, Ltd., London.—Illustrated circular describing their automatic exhaust relief valves; also a 20 pp. illustrated pamphlet (roughly 7½ in. × 4½ in.) giving brief general information concerning their water-tube boilers, superheaters, chain-grate stokers, water softeners, and silent gravity bucket conveyor. The firm have extended their department for the manufacture of all accessories required for steam plants and kindred work. Besides superheaters, chain-grate mechanical stokers, feed-water heaters, water purifiers, steam, feed and exhaust piping, they have extended their mechanical conveyor department dealing with the conveying of all kinds of material, such as coal, iron, ore, chalk, cement, &c., and they now undertake structural steel work. They have also recently taken up the manufacture of electric cranes.

Messrs. John Brotherton, Ltd., Imperial Tube Works, Monmore Green, Wolverhampton.—New catalogue (about 6½ in. × 5 in., 90 pages, in neat green cover) containing a good deal of tabulated information, brief descriptive notes, and numerous illustrations of the various tubes and fittings manufactured by them for many purposes. Boiler tubes, telegraph and tramway poles, bracket work, patent joint tubes for collieries, &c., are among the lines included.

Messrs. E. P. Allam & Co., London, E.C.—List No. 28, briefly describing, illustrating and pricing their Premier motor-starting and reversing switches and speed regulators; No. 40 details the Premier lift controllers.

Messrs. Wade & Jones, Ltd., Colmore Row, Birmingham.—Eight-page illustrated pamphlet, showing and very briefly particularising their 12-16-h.p. oil dynamo for ship and country house lighting.

The Worthington Pump Co., Ltd., London, E.C.—Special marine catalogue B.E. 106, consisting of 160 pp. (6 in. × 9 in.) fine art paper. The volume, for that is the best description to give it, sets out very full information concerning the multifarious marine pumps and other specialities of the company. No praise could be too high for the very fine process illustrations in which the book abounds. Our readers can have copies of the catalogue on application.

Messrs. Supplies, Ltd., 9, Parr Street, Liverpool.—24-pp. pamphlet (4 in. × 11 in.), telling the trade a few "notable facts" concerning their "Supplies" electric radiators which they are manufacturing in antique copper and brass, oxydised steel, dead gold, or steel and copper. The distinctive feature of these radiators is the self-contained meter, which is placed conveniently in the front, so that the owner or user may see the consumption record for himself, and "check undue use." A number of good designs are shown in the list, and prices are stated.

The *Brush Budget* is as entertaining as ever in its September issue, and from our previous notices readers will know how entertaining that is.

Messrs. Johnson & Phillips, Ltd., Charlton.—New feeder pillar and junction-box price list (J) (24 pages, 8½ in. × 11 in.) containing descriptions, with many good half-tone illustrations, of feeder and switch pillars, feeder and main disconnecting boxes, main fuse distribution, plug house service and joint-boxes, also telephone pillars. Various types of frames and covers are also shown, and prices of insulating oil and junction box compound are given. A copy of this list will be sent to anyone intimating an interest therein.

Book Notices.—"The Indicator Handbook." By Chas. N. Pickworth. Third Edition. Part II, The Indicator Diagram: Its Analysis and Calculation. London and Manchester: Emmott and Co., Ltd. 3s. net.

"Proceedings of the American Institute of Electrical Engineers." Vol. XXV, No. 8, August, 1906. New York: The Institute, 95, Liberty Street.

"Engineering Press Monthly Index Review." Vol. VIII, No. 6, September, 1906. Brussels: Association de la Presse Technique. 2.50 fr.

"Transactions of the South Yorkshire Association of Mining Students." Vol. I, No. 5, September, 1906. London: The Chichester Press.

Export Packers' Card.—We have received a card compiled by Mr. Samuel Tozer, giving instructions for marking and stating weights on packages for exportation. A list of the principal countries of the world is given in table form, and against each country is set out the manner in which goods for export should be marked to meet the requirements of the various colonial and foreign Customs authorities. This card should prove very useful to the "shipping or export department," and copies can be obtained from Messrs. Tozer, Howard & Co., 72, Leadenhall Street, E.C. Price 6d. each.

Dissolutions and Liquidations.— British Electrical Tool Co., Ltd.—This company is winding-up voluntarily with Mr. C. S. Holliday, Greek Street, Park Row, Leeds, as liquidator.

British Electric Signs Co., Ltd.—A meeting is to be held at Dashwood House, E.C., to hear an account of the winding-up from the liquidator (Mr. G. Ensor Mount).

Consolidated Telephone Construction and Manufacturing Co., Ltd.—A meeting is to be held at Salisbury House, E.C., on October 19th, to hear an account of the winding-up from Mr. G. S. Howell (liquidator).

Messrs. T. Barnes & Son, electricians, Birmingham and Erdington.—Messrs. T. Barnes and C. R. Barnes have dissolved partnership. Mr. C. R. Barnes will continue the business, and attend to debts.

McGuire Manufacturing Co., Ltd.—Notices appear in the *London Gazette* of a supplementary dividend of ½d. in the £, payable on September 25th, at 58, Coleman Street, E.C.

Tangye Tool and Electric Co., Ltd.—This company is to be amalgamated with Messrs. Tangyes, Ltd., and for that purpose voluntary liquidation has been resolved upon, with Mr. W. J. Parkins as liquidator.

General Contracts Co., Ltd.—This company is winding-up voluntarily as "by reason of its liabilities it cannot continue business." Mr. George T. Feasey, 9, Old Jewry Chambers, E.C., is liquidator.

Cooper Patent "Anchor" Rail Joint Co., Ltd.—Creditors are required to send particulars of their debts, &c., to Mr. W. Crosland, 43, Albion Street, Leeds, the liquidator, by November 6th.

Works Visit.—Last Saturday week about 40 members of the Darwen branch of the National Amalgamated Union of Engineers visited the works of Messrs. Ed. Bennis & Co., Ltd., Little Hulton, when the firm's various manufactures were explained to the visitors by Mr. Alfred W. Bennis, M.I.Mech.E., &c., and members of the staff. The Bennis patent stokers and self-cleaning compressed air furnaces, and the new improved patent smokeless chain-grate stoker—specially adapted for water-tube boilers—were shown in operation. Other manufactures inspected were several elevators and portions of conveying plant approaching completion. The process of multiple moulding by machinery in the foundry also excited interest. A visit was made to the laboratory, where one of the firm's chemists gave a practical demonstration by calorimeter to show the heat value of any given coal could be ascertained. During the afternoon Mr. Alfred W. Bennis addressed the visitors briefly on boiler efficiency, furnace temperatures, fuel economy, the need of fine air spaces in furnace construction, &c. After a repast provided in the ancient hostelry of Little Hulton—the Kenyon Arms—the president of the Darwen Society, Mr. Peers, expressed hearty thanks for the kindness shown by Messrs. Bennis and their staff in opening the works, and explaining everything to them. It had been most interesting and instructive to their members, and he felt that, if employers would only give their employés more opportunity of actually seeing new machinery and mechanical processes as well as reading about them, both would derive benefit therefrom.

Norwich Electrical Exhibition.—The Norwich Corporation is arranging to hold an electrical exhibition from October 16th to November 8th, and we have no doubt that a fillip will be given to electricity supply business in the city as a result. A notice of interest to would-be exhibitors appears among our advertisements to-day.

Bankruptcy Proceedings.—Lazarus Blumenthal.—The public examination was held on September 11th before Mr. Registrar Hope at the London Bankruptcy Court, of Lazarus Blumenthal, dealer in electric telephones, lamps and fittings, 78, Queen Victoria Street, E.C. The matter has already been referred to in our pages. The examination was concluded.

Mr. Charles Hubert Hegley, electrical engineer, of 33, Weston Road, Stroud, has filed his petition in the Rochester Bankruptcy Court. His affairs are now in the hands of the Official Receiver (Mr. R. T. Tatham).

W. H. L. Watson and G. Huntington (Watson & Huntington, electricians, Battersea Rise and Bond Street, London). October 3rd is the last day for receiving proofs for intended dividend. Mr. F. S. Salaman, 1, Oxford Court, Cannon Street, E.C., trustee.

For Sale.—Messrs. J. Stone & Co., Ltd., of Deptford, are offering for sale some gas engines, dynamos and electric motors. Particulars appear in our advertisement pages to-day.

LIGHTING and POWER NOTES.

Ashton-under-Lyne.—The T.C. has adopted the two-rate meter system as an alternative to the present methods of charging, with the following rates:—Between 4.30 p.m. and 11 p.m., at scheduled rates; viz., first 250 units per quarter, 3½d. per unit; next 250, 3d.; beyond, 2½d., less 5 per cent. discount. Between 11 p.m. and 4.30 p.m., 1d. per unit. Two-rate meters are to be charged for at 10s. per quarter.

Bacup.—The quarries of Messrs. R. Siddall, Brandwood Moor, Stacksteads, have just been fitted up with a complete electrical installation to take the place of steam power; a 250-kw. Browett-Lindley-Westinghouse set has been installed which is now supplying energy at 500 volts to various motor equipments, including two 10-ton cranes.

Bangor.—A L.G.B. inquiry was held on September 12th into the application of the T.C. for a loan of £2,700 for electricity purposes, and there was no opposition.

Bideford.—The T.C. has received from Mr. J. J. Purves, of Exeter, on behalf of Messrs. Foote & Milne, Ltd., an offer to install the electric light in the town, and then to lease the installation to the Council at a fixed rental. The Council has resolved to reply, as in several former cases, intimating that it intends itself applying for a prov. order.

Burslem.—The Council has adopted the following amended scale of charges for energy for power: Up to 250 units, 2d. per unit; 250 to 500, 1½d.; 500 to 25,000, 1d.; 25,000 to 50,000, ¾d.; beyond, ½d.

Chester.—An electrical exhibition was held by the Corporation in the Assembly Room at the Town Hall from the 5th to the 14th inst. Judging by the number of well-known firms that exhibited and the great variety of fittings, dynamos, motors and domestic appliances, as well as the very up-to-date lighting apparatus of every description that was shown, the exhibition must have been a very successful one. We trust it will stimulate a much larger demand on the Corporation mains, especially in view of the fact that prices are, as from October 1st next, to be considerably reduced. The charge for private lighting is to be reduced from 4d. to 3½d. per unit, and for power purposes from 2d. for the first 500 units per quarter, and 1½d. after, to 1½d. for the first 200 units per quarter, and 1d. per unit for all above that quantity. Discounts, meter rents, and the minimum charge for lighting during the winter quarters, will, however, remain unaltered.

Continental Notes.—Italy.—A concession has been sanctioned for the erection of a hydro-electric plant on the river Lamone at Brisighella. La Società Elettrica Frentana, with a capital of £10,000, proposes to erect a power station at Lanciano for lighting the town.

Spain.—La Sociedad Hidro-Electrica del Tronceda is about to put down a plant at Mondonedo (Lugo) to supply energy for lighting and power.

Belgium.—An electric power plant is to be put down at the collieries of the Société des Charbonnages du Nord de Charleroi. The plant will comprise a 300-h.p. alternator and a number of transformers and motors.

Ealing.—The results of the past year's working of the Corporation electricity undertaking we give below, together with comparative figures for 1905 :—

Year ended March 31st.	1906.	1905.
Total revenue	£24,969	£22,498
Total working costs	12,108	11,872
Gross profit	12,861	10,626
Interest	5,186	4,834
Sinking fund	5,357	4,685
Net profit	£2,318	£1,107
No. of 8-c.p. lamps	99,477	86,583
No. of public lamps..	73 arcs, 1,487 inc.	73 arcs, 1,462 inc.
Units sold	1,378,334	1,194,651
Average price obtained per unit..	4·34d.	4·51d.
Total working costs per unit ..	2·10d.	2·38d.
Maximum load	1,096 kw.	1,003 kw.
Total capacity	1,770 kw.	1,100 kw.
Capital expended	£185,156	£173,612

Ferryhill.—The P.C. is negotiating with Messrs. Bolckow, Vaughan & Co., for a supply of energy for lighting Dean Bank. It is proposed to erect 48 lamps.

India.—Madras.—The Madras Government has sanctioned an electric fan installation for the Guindy residence of the Governor of Madras. The installation will be a separate one, as it was found that the cost of a connection with the mains of Messrs. Crompton & Co., who have a licence for the supply of energy for general purposes in the City of Madras, would be prohibitive, Guindy being about 8 miles distant. The cost of the separate installation is estimated at £4,000.—*Indian Engineering.*

The same journal states that proposals are under consideration to amend the Indian Electricity Act.

Kettering.—The U.D.C. has altered the charges for the supply of motors on hire from 8 per cent. for a minimum term of three years to 10 per cent. for five years.

London.—Camberwell.—Several of the London B.C.'s at times endeavour to force very arbitrary, and, it would seem, ridiculous conditions upon supply companies when granting permission for mains to be laid in or through their areas, and the attitude adopted by the Camberwell B.C. forms no exception to the general rule. A report circulated on Monday last stated that application had been made from time to time by the City of London Electric Supply Corporation in respect to the laying of the mains. In each case the Council put in a provision that the mains should be laid solely for the supply of electricity in the borough. The company has appealed to the B. of T. in the matter, and that body has replied "that pending the consideration of the question of the introduction of general legislation, they consider it desirable that they should postpone giving a decision in regard to the appeals, it being understood that the company are allowed to continue their work without prejudice to any decision which the Board may give on the appeals." The B.C.'s Committee is to communicate with the B. of T. on the matter, it being dissatisfied with this reply by the Board.

Bermondsey.—Loans of £2,635 and £2,000 for condensing plant and mains extensions respectively, are to be taken up. The town clerk is to act as Parliamentary Agent in connection with the application to the B. of T. for a prov. order for the St. Olaves district.

Lowestoft.—The T.C. has decided not to supply arc lamps on the hire system, but only to maintain those of approved makes at from 5s. to 10s. per quarter, according to size and make, in addition to the charge for energy.

Manchester.—The need for considerable extensions, in order to meet the prospective demand for current, has led to proposals for a re-arrangement of the city electricity works. Two reports on the subject by the chief engineer (Mr. S. L. Pearce) are at present in the hands of the Electricity Committee, but they have not yet been made public. It is understood, however, that one deals with an extension of the generating plant (which Mr. Pearce recommends), whilst the second relates to the Committee's future policy for the more economical working of the whole undertaking. The reports will first be considered by the Committee, and their conclusions will be presented to the City Council at its meeting in October. Estimates have been prepared which show that the contemplated extension is imperative. The Committee have noted carefully the percentage of increase, year by year, in the supply of energy, and it is calculated that, should the increase be maintained in the same proportion, the consumption will, by the end of 1907, have reached the maximum limit of supply, and without suitable provision, the works will not be capable of meeting the requirements of the year following. There are at present three generating stations, situated in Dickinson Street, Bloom Street, and Stuart Street. The Dickinson Street station is the oldest and least economical in working ; Bloom Street comes next in respect of age ; and Stuart Street, the most recent, is the most economical. The Committee hope to devise a scheme which will admit of the stations being worked more economically during the greater portion of the year, and the shutting down of the least economical—that at Dickinson Street—during the summer season.

Otley.—About four years ago the U.D.C. obtained an E.L. prov. order. An arrangement has now been made with the British Westinghouse Co., by which, subject to the sanction of the B. of T., the order will be transferred to that company, which undertakes to supply both power and light.

Ravensthorpe.—With regard to the application of the U.D.C. for a loan of £2,650 for E.L. purposes, the L.G.B. wrote stating that as there were only 27 applications for energy, there would be little prospect of the undertaking being financially successful unless the demand was likely to be largely increased. The Board, therefore, desired information as to whether any further applications for supply were likely to be made.

Sheffield.—Mr. S. E. Fedden, the engineer and manager to the Corporation Electricity Supply Department, is arranging an exhibition of electrical machinery and appliances in the Corn Exchange, which is to be opened by the Lord Mayor at 3 p.m. on the 27th inst. The exhibition will remain open to the public daily from noon to 10 p.m. until October 20th.

A number of exhibits of much interest to the local and metallurgical and engineering industries have been secured, as well as an elaborate display of domestic and public lighting apparatus. The exhibits will include an electric kitchen, a Kjellin steel furnace in operation, electro-plating, and a Schmeltsbad hardening and annealing furnace in operation, electric welding, glow lamp making, photo-printing, confectionery, laundry work, X-ray work, electro-medical appliances, electric lighting and heating apparatus, &c.

South Africa.—Johannesburg.—A report dated August 20th, 1906, states that, owing to a sudden breakdown of one of the 2,000-h.p. gas engine generating sets at the same time as the other 2,000-h.p. set was undergoing repairs, much trouble and inconvenience has been caused both to the electric lighting and to the tramway service.

Cape Town.—The Cape Parliament has passed a vote for £50,000 to be expended in electric lighting on the Eastern and Midland Railway systems. It is understood that the money voted will be principally expended on the "Stone" system of railway carriage lighting. The lighting of some of the more important railway stations is, however, included in the vote. The Western Railway system has had the advantage of electric lighting for several years, the carriage lighting being effected by an oil engine and dynamo in the brake van of each train.

West Ham.—At a L.G.B. inquiry held on Tuesday with regard to an application of the Council to borrow £75,651 for electric lighting purposes, it was stated that the sum named included £17,635 excess expenditure on old works. Mr. Seabrook, the electrical engineer, in his evidence said the existing machinery was by no means equal to its estimated capacity. The Inspector pointed out that the £17,634 included £4,307 in regard to buildings which had been demolished and machinery which had been running since 1898. No loan had been sanctioned for this expenditure, nor had any sum been set aside for a sinking fund. It was unfortunate that the undertaking should have been worked in such a way. The L.G.B. would certainly not grant a loan for buildings which had been demolished, nor would it grant a loan in respect of the sum on the machinery and buildings, which was equal to the amount which should have been set aside for a sinking fund. The expenditure on Abbey Mills should have been written off four years ago, but this had not been done. The Council would have to consider how it was going to pay these large amounts, for which a loan would not be granted by the L.G.B.

TRAMWAY and RAILWAY NOTES.

Belfast.—The Corporation has put into service this week a top-deck covered car as an experiment.

Bristol.—Last week 18 tram conductors were summoned at the Police Court for overcrowding on cars of the Tramways and Carriage Co., during a period of exceptionally heavy traffic due to a recent football match. From the report of the case it appears the company did all it possibly could to deal with the large number of people who desired to travel to and from the match, and when such heavy demands for car accommodation occur, we fail to see any remedy for such overcrowding. The people insist on getting on the cars. However, the magistrate acknowledged the difficulty, and imposed only a moderate penalty, *i.e.*, 10s. and costs in each case. Mr. C. Challenger, the traffic manager, on the afternoon in question, supplemented the 20 ordinary cars on the Bedminster lines by 38 special cars.

Chile.—The German Consul at Valparaiso, in a recent report, states that the Aktiengesellschaft Strassenbahn Valparaiso, of Berlin, are the owners of the tramway system of Valparaiso, as well as of a line in Vina del Mar and of the line which unites these two towns. For the most part electric traction has been adopted, and this will be extended. In 1905 the German Oversea Electrical Co. purchased the shares of the Chilian Electric Tramway and Light Co., of London, which owned the Santiago tramways, so that these are now practically a German concern. With the exception of the lines named, there are no electric tramways in Chile, although several are proposed, notably the lines between Concepcion and Talcahuano, and between Valparaiso and Santiago *vid* Casablanca.

Continental Notes.—Germany.—An electric tramway is to be constructed in the town of Flensburg.

Greece.—The Austrian Consul at Athens reports that the project for the electrification of the tramway from Piræus to Athens has been accepted by the Greek Government.

Darlington.—The manager of the Corporation tramways has issued a report, at the request of the Tramways Committee, on the trial which has been made with ½d. fares. He goes fully into the question, and arrives at the conclusion that ½d. fares are not remunerative. To arrive at a satisfactory comparison between ½d. and 1d. fares he suggests that 1d. fares should be given a twelve-months' trial, and if it were found at the end of the twelve months that there was no improvement, it would be a simple matter to return to ½d. fares. Gloucester, Lancaster and Bexley recently abandoned ½d. fares after giving them a trial.

East Ham.—The results of the past two years' working of the Corporation tramways undertaking are as follows:—

Year ended March 31st,	1906.	1905.
Total revenue	£44,082	£37,754
Working costs, including management	28,696	26,360
Gross profit	15,386	11,394
Interest charges	5,833	4,892
Sinking fund	4,861	3,890
Net profit	4,692	2,612
Depreciation	1,193	2,612
Capital expenditure	£163,049	£152,277
Length of single track	12·77 miles	12·25 miles
Car-miles	961,812	863,816
Passengers carried	14,444,290	13,689,658
B. of T. units used	1,073,990	951,543
Receipts per car-mile	10·77d.	10·49d.
Working expenses per car-mile	7·01d.	7·32d.

At March, 1905, the net profit of £2,612 was allocated to depreciation, bringing that account up to £2,954. At March this year, £1,193 was set aside to depreciation, increasing the fund to £3,450. A sum of £1,750, unappropriated revenue at March 31st, 1905, was brought forward, and, together with the profit balance available at March last (£3,499), was allocated to the relief of the borough rates. Considerable discussion arose at the B.C. meeting, held last week, in respect to the sum of £1,193 put this year to depreciation and renewals. The E.L. and Tramways Committee recommended that the sum be held in suspense until the estimates for the general district rate come up for consideration. Councillor Oakes moved an amendment that the amount stand as allocated in the accounts; he dealt with the question in a businesslike manner, and the amendment was carried by a majority of one. Notice of a motion to rescind the resolution at the next meeting was given.

Halifax.—At a special meeting of the T.C. to consider a proposal that the tramways dispute be referred to arbitration, it was stated that the proposal was too late, as the vacancies had been practically all filled up.

On Tuesday a full service of cars was put on all routes, and we gather some of the men have made application for re-instatement.

Harrogate.—The T.C. has by 15 votes to 9, adopted the recommendation of the Highways Committee not to support the application of a local syndicate to the Light Railway Commissioners for an order authorising the construction of tramways for Harrogate, and through to Starbeck and Knaresborough. The contention is that tramways would be injurious to the town.

Hebburn.—The U.D.C. has formed a deputation to wait on the B.E.T. Co. with a view to the introduction of tramways in the district.

Leeds.—About 11 months ago the Corporation undertook an experiment with the "Romapac" system of permanent way construction. A length of 150 yards was laid on the "Romapac" system in Otley Road, Headingley. The feature of the new rail was its "patent renewable top." The Municipal Tramways Association, which meets in Leeds this week, will have an opportunity of inspecting the results of the 11 months' wear and tear of this new rail. The metals are said to be unmistakably loose, and need rolling and binding again. The manager of the Leeds Tramway Department expressed the opinion to a Press representative, a few days ago, that the theory is undoubtedly good, but this being the first experiment of the kind, the workmanship may have been defective. At any rate, the Corporation is so far satisfied with the result that it is laying another experimental section, on the same principle, in Kirkstall Road. The rails that are being taken up in Kirkstall Road were laid in 1896; they have, therefore, had about the average "life"—that is, 10 years. The real object is to show that one rail base will outlast three "tops." In other words, the base ought to be re-topped three times before the entire structure is renewed. Much, however, depends on the strength of the concrete foundation; if this is not good, the rail base will inevitably work loose.

The "Romapac" system of permanent way construction was fully described in the Electrical Review of February 16th last.

Liversedge.—The U.D.C. on September 13th received from the B. of T. an intimation that it has extended the period for constructing the tramway between Hightown and Cleckheaton *vid* Hartshead Moor, for two months from September 30th, so as to afford further time for progress with the negotiations as to the construction and working of the lines. The Board added that if at the end of that time the B.E.T. Co. adhered to the application for abandonment of powers, full opportunity will be given to all parties who had objected to lay their views before the Board.

London.—Camberwell.—In connection with the electrification of the London Southern Tramways, the L.C.C. has informed the B.C. that in deference to the views of the latter body the overhead system of construction shall not be carried out in Denmark Hill.

Manchester.—It seems clear, from recent reports, that the business of parcel carrying inaugurated by the Tramways Department of the Corporation is not going to be a financial success. At the last meeting of the City Council the Chairman of the Committee, Mr. Alderman Bowes, replying to a question, said that the Committee was preparing a report as to the future policy of the department, which would be laid before the Council. In May it was announced that the actual loss on the preceding year's working amounted to £5,500. The current year, it was expected, would show more favourable results. The promised report by Mr. McElroy, the general manager, with regard to the parcels business, is now in the hands of the Committee. It shows that the provision of vans, horses, and other requisites—besides the renting of parcels depôts—has been a costly business. This year the Committee became involved in costly litigation. The work of the parcels department has been handicapped by the fact that incoming parcels for delivery have not been received in such large numbers as parcels for dispatch to different parts of the city and outside districts. The cause is obvious. The parcels department is, therefore, the report says, not successful financially. The report is a statement of facts rather than an expression of opinion or statement of future policy; and it will be for the City Council at its October meeting to decide whether the parcels business—from which much had been hoped—shall be continued as it stands, be restricted in its scope, or dropped altogether.

Mansfield.—The strike has been settled. The directors have agreed to pay the motormen 5½d. an hour at once and the conductors 5d., and to reconsider the whole question in six months. The men agreed to accept an advance of ½d. per hour for conductors, to commence at once, and a similar advance in January. The motormen are to have an advance of ½d. per hour at the end of six months. Running was resumed on Saturday.

Salford.—Discontent among the motormen and conductors in Yorkshire and Lancashire seems still to be rife, this time an outbreak has occurred at Salford. About 750 men are affected over a dispute as to wages. It is suggested that the matter shall go to arbitration. The Tramways Committee has called a meeting to discuss the question.

South Africa.—East London.—The town electrical engineer has presented a report to the Council recommending certain alterations in the tramway service which will effect a total saving of £7,700 per annum.

South Lancashire.—The B. of T. officials inspected the Lancashire United Tramways Co.'s additional lines from Boothstown to Swinton, and from Walkden to Swinton, at the beginning of this week. The company's new sub-station in Walkden is approaching completion, and from it the new lines in the Walkden, Swinton and Farnworth districts will be operated. A large number of factory operatives are now using the system from Walkden to Farnworth, contract tickets at reduced rates being issued for their benefit.

Swindon.—In respect of the accident at Swindon in June last, it is reported that claims for damages have been sent in to the amount of £30,000. It is believed that this can be cut down to £12,000, but even to meet this amount would mean a call for a shilling rate. The *Westminster Gazette* states that the tramways have been run at a loss of £1,000 for six months, and the Finance Committee of the Council proposes to investigate the business management of the undertaking.

Lieut.-Col. Von Donop's report on the accident has been issued. The car was descending a hill, when the driver lost control, and, on reaching a curve at the bottom of the hill, it overturned. There were between 70 and 80 passengers on the car at the time and nearly all of them were more or less injured. Two were killed on the spot and three died later on in the hospital. Lieut.-Col. Von Donop is of opinion that the accident was primarily due to a failure of the brake mechanism, he has no hesitation in saying that he considers that an error of judgment was made in employing a new car on this route on the day of the Bath and West of England Show. The driver, moreover, had never had charge of the car before on this particular route, and it was injudicious to employ on the route a new car with which the drivers had not had thorough experience. The question also arose whether the car should not have been removed from the route in consequence of complaints made regarding it. It was an error of judgment for which Mr. Medcalf, the traffic manager, must bear the responsibility. Whilst, however, it was a mistake on Mr. Medcalf's part to have left the car on the route, it must be said in his favour that, after examining the car, he was of opinion that the defect of which drivers were complaining was one which might cause inconvenience to passengers, but would not affect the efficiency of the brakes. Accordingly he took steps to have the defect remedied by sending a fitter to do it while the car was waiting at the Corn Exchange. The adjustment could easily have been carried out if the fitter and the motorman Lyons had been really desirous of having it done, and both were greatly to blame for not carrying out Mr. Medcalf's instructions.

United States.—Brooklyn, N.Y.—It is promised that the outside work of the subway, now being constructed on the "cut and cover" principle, shall be finished by Christmas. The Brooklyn Rapid Transit Co. reports gross earnings of £3,800,000, representing nearly 1 million passengers a day, for the year ending June 30th. The company has now 558 motor-cars and 269 trailers on its elevated electric lines. Glass fronts are being fitted to 1,215 of the surface cars to protect the drivers against the winter weather. On a recent evening, between 5.30 and 6.30 o'clock, the B.R.T. operated 61 trains across Brooklyn Bridge in one direction, using a combination of electricity and cable service. The headway was as low as 45 seconds, the trains being loaded in about 90 seconds at two platforms; the tracks interlace, and the trains operate without switching. Public indignation has been temporarily abated in the matter of charging a double fare to the Coney Island pleasure resorts, by issuing a receipt, redeemable if the courts decide against the company. A new route is being laid to Coney. Since introducing electric traction 15 years ago, a committee of a local Ratepayers' Association reports that the B.R.T. has killed 900 persons with its cars, and injured 3,600 others.

Chicago, Ill.—Mr. Joseph Ramsey, jun., formerly president of the Wabash Railroad, announces complete plans for an electric railway, about 815 miles in length, between Chicago and New York, to be finished within three years. The line is to be double track, and will be financed by European capital.

New Haven Railroad.—The N.Y., N.H. and Hartford Railroad has sold its interest in a large number of electric car lines in Massachusetts and Connecticut, in anticipation of a test of its legal right to engage in such business.

New York City.—Reiterated denials that any unusual trouble has developed in the construction of the Pennsylvania Railroad tunnels which will connect the city with Long Island, are set against many statements of workmen refusing to enter the compressed air chambers, and stories of water, feet deep, in the heads of the excavations. Elaborate cooling apparatus is being installed in the city subway, but a test of the temperature shows that the devices are not effective.

Walsall.—The B. of T. has approved of the proposed mode of reconstructing the old tramways, and has consented to the substitution of double for single lines to Bloxwich, and from the Bridge to Princess Street, Pleck, subject to the provisions of the Walsall Corporation Act, 1900, for the protection of the frontages. The Committee has received certain objections from frontagers where there is less than the prescribed width between the outer rail and the kerb, and proposes to hold a conference with them for the purpose of seeing to what extent such objections can be met.

In consequence of a request from the Walsall tramway employés that they should be paid extra for Sunday work, the Tramway Committee has made inquiries of over 50 tramway undertakings respecting the rules of pay. The Committee finds that only a small number pay extra for Sunday labour, and that the rate paid to the employés at Walsall is higher than that paid by many towns of a similar size; as the Walsall rate was fixed in view of the fact that Sunday labour was included, the Committee has decided that it cannot accede to the application of the men.

Yarmouth.—The T.C. has decided to extend the car-shed depôt and to erect a workshop at an estimated cost of £2,000, exclusive of the cost of lathes and tools.

TELEGRAPH and TELEPHONE NOTES.

Australia.—The official estimates for the proposed Melbourne-Sydney trunk telephone line show that the total cost of the line is set down at £37,812, after making an allowance of £5,182, the value of material recovered on account of re-poling a portion of the line and available for other works. This is divided between the two States thus:—New South Wales, £30,204; Victoria, £12,791. The heaviest items are for the hard-drawn copper wire:—223 tons, at £100 a ton, used on the New South Wales side, £22,300; and 107 tons, used on the Victorian side, £10,700. The sum to be set aside annually for depreciation, renewals and maintenance is £3,780; and the loss likely to ensue through a diminution in telegraphic and postal receipts is estimated at £2,500 a year. The revenue anticipated is £4,714 a year, "assuming the charge for each conversation of three minutes' duration between Melbourne and Sydney to be 6s., and conversations between intermediate stations to be at regulation rates."—*Australian Mining Standard.*

Cable Canard.—During last week it was stated in the Press that the Anglo-American Telegraph Co. was about to lay a new Atlantic cable out of the reserve fund, but the statement was afterwards denied by the company, which stated that it owned sufficient cables. It is thought that the rumour was started to depress the market for the shares of the company.

French Indo-China.—The year 1904 was a particularly bad one for the Indo-China telegraph system. Rains, typhoons and floods have called for constant effort on the part of the *personnel* and an enormous amount of work to ensure the proper maintenance of the line. The typhoons of May 1st and September 3rd in Cochin China and Cambodia caused damage to the extent of 30,000 piastres, and that of September 11th and 12th in Annam also caused great damage to the telegraph lines. At Laos, in the wooded districts, storms threw many trees on to the wires, which by reason of floods could only be repaired under great difficulties and dangers. Elephants in the south of Annam also caused much damage, although not to such an extent as in the previous year. The landline between Saigon and Hanoi was worked almost without interruption. The Baudot system is installed between Hanoi and Haiphong, and works perfectly. The Haut-Mekong line was completed by the erection of the line between Vientiane and Luang-Prabang. Telephonic communication at Hanoi was established and is being completed at Haiphong.

On July 1st, 1905, the system totalled 13,850 kilometres of line—an increase over the previous year of 1,050·8 kilometres; the length of wire was 25,157 kilometres—an increase of 2,227·9 kilometres over last year. During the year 108,340 fr. were expended on the upkeep of the system.

There were 252 telegraph offices and 85 belonging to railways.

Inland traffic and revenue for 1904 was 563,860 telegrams and 355,676 fr., and for the first half-year of 1905 291,337 telegrams and 191,294 fr.

International traffic for 1904 was as follows: Telegrams received, 30,145; dispatched, 30,686; and in transit, 18,334, all bringing in a revenue of 963,126 fr. The figures for the first half-year of 1905 were 17,904; 17,422 and 9,720 respectively, and the revenue 490,568 fr.—*Journal Télégraphique.*

Glasgow.—The Postmaster of Glasgow has issued a circular to telephone subscribers, in which he gives particulars of the new conditions of working. The system will, of course, be reorganised, and a new central exchange will be built to replace the obsolete plant at present in use. Terminal fees will be abolished, and intercommunication will be established between subscribers to the Post Office and National Telephone Co.'s systems. It will be necessary to introduce a new tariff, and this, of course, means a higher scale of charges. The circular remarks that the present rates are "*scarcely remunerative.*" Quite so. The additional advantages foreshadowed are not to be granted to subscribers until they accept the new and increased tariff.

India.—Two sets of Murray printing telegraph apparatus will be installed between Bombay and Calcutta in October as an experimental measure.—*Indian Engineering.*

Japan.—The British Consul at Yokohama, in a recent report, states that the telegraph wire trade of Japan is almost entirely in the hands of the Germans, the British share being only £3,532 out of £74,869, and the difference in price precludes much hope of an improvement.

New German-Norwegian Cable.—As a result of the increasing traffic between the two countries, the telegraph administrations of Germany and Norway decided to establish on joint account a new submarine cable between Cuxhaven and Arendal, especially for communication between Hamburg and Christiania. The order for the cable, having a total length of 409 miles, was given to the North German Marine Cable Works Co., of Nordenham, and the cable was completed at the end of July. A length of 25 miles was laid early in August to the mouth of the Elbe, near Duhnen, and the usual tests yielded satisfactory results. The cable steamer *Stephan*, which carried out the work, then took on board the remainder of the cable at the beginning of September and proceeded with the laying. A splice with the cable was first made near Duhnen, and a further section was laid to the latitude of Heligoland, where the end was buoyed. The steamer next sailed to Stolvvig, near Arendal, which was reached on September 4th, but the existence of a thick fog prevented the landing of the coast section until the following day. On that day the laying of the main cable was begun towards the buoyed end, where the final splice took place on the 8th. The subsequent tests showed the cable to be in a faultless electrical condition.

Telephone Cable across Lake Constance.—As mentioned recently in this column, a new telephone cable has been laid across Lake Constance by virtue of an agreement arrived at between the German States of Wurtemberg and Bavaria on the one hand and Switzerland on the other. The cable, in which the so-called Pupin induction coil system has been introduced, has been laid between Friedrichshafen, in Wurtemberg and Romanshorn, in Thurgau, and it has a total length of slightly over eight miles. An attempt was made to lay the cable in September, 1905, but it had to be abandoned on account of the cable being damaged in laying, and also because faults developed at the places where the induction coils were inserted. Alterations were made in the cable and in the position of the coils, and the actual laying was carried out in August of the present year. The cable consists of seven twin conductors, which are air and paper insulated and lead-covered by a sheath of 3 mm. thickness. A strong continuous steel wire spiral is arranged under the lead covering in order, among other purposes, to give it sufficient resistance even at the deepest parts of the lake to the heavy water pressure, which is put at 60 atmospheres, or 900 lb. per sq. in. The lead sheath is protected against external damage by means of armour composed of 40 round iron wires 4 mm. in thickness. The diameter of the cable is 5 centimetres, and it increases to 15 centimetres where the coils are built in. At each end is a shore end of a length of ·31 mile, which is more heavily armoured than the

main section, in order to provide against damage by shipping, in consequence of the shallow water in these places. The cable was placed upon a boat fitted with laying machinery, and was arranged alongside a passenger steamer, which supplied the steam for working the plant. After many experiments, trial trips, and placing of buoys in case of fog arising, the laying of the cable was commenced on August 8th from the Wurtemberg shore. After a length of a mile and a quarter had been sunk the measuring apparatus both on the ship and on land revealed a fault, which was localised; the cable was picked up, the fault cut out, and the laying operation was begun again on the following day. The work was then completed in 2½ hours, notwithstanding that a severe thunderstorm rendered it difficult to effect a landing on the Swiss shore. Communication was at once opened with Stuttgart, Munich, Berlin and Berne, and the results are stated to have been extremely favourable.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1.)	Aug. 26, 1901	
Dominica-Martinique	May 7, 1903	
St. Lucia-Martinique	May 7, 1903	
Reissa-Issa (Yemen) Camaran	Oct. 22, 1903	
Cayenne-Pinheiro	Aug. 15, 1903	
Port Arthur-Chifu (Closed)	Mar. 7, 1904	
Tarifa-Tangier	Jan. 18, 1904	
Garachico (Tenerif)-Santa Cruz	July 12, 1906	
Bolamo-Bissao	July 24, 1906	
Curacao-La Guayra / Curacao-Coro — Closed	Jan. 11, 1906	
Mole St. Nicholas-Port au Prince	Aug. 16, 1906	
Sierra Leone-Conakry	Sept. 12, 1906	Sept. 14
Las Palmas-Grand Canary	Sept. 18, 1906	
Arecife-Las Palmas	Sept. 18, 1906	
Landlines.		
Puerto-Barrios	Aug. 28, 1903	
Bachkale-Deliman	Feb. 12, 1906	
Bagdad-Bassorah	July 17, 1906	
Havana-Cienfuegos	Sept. 14, 1906	Sept. 18

Wireless Telegraphy.—Some interesting experiments were recently made by the Austrian army in connection with portable stations in the area extending between Pressburg, Znaim and Korneuburg. Instead of using a balloon or kites, the Austrians employed masts 150 ft. high, arranged in sections and capable of being rapidly built up into a whole. According to a Vienna newspaper, this system overcomes the defects incidental to the suspension of the aerial conductor from a balloon, the failure which takes place when there is a slight wind and the clumsiness of the method of transport. In lieu of a train of from 25 to 30 carts, the built-up mast system only requires three carts to transport a station and plant complete. The stations are quickly brought into operation, and again made ready for marching onwards. The erection of the mast, which is undertaken by the station *personnel*, only occupies from two to three hours, while less than an hour is required for dismantling and packing up ready for removal elsewhere. The mast and its umbrella-like conductor network are said to be able to resist a storm of wind. During the experiments it was possible to telegraph a maximum distance of 69½ miles, that is to say, between Pressburg and Znaim. At the town of Pressburg was a fixed station, while the positions of those at Znaim and Korneuburg were constantly changed, and it was possible to bring them into service easily on arrival at the fresh destinations. It is claimed that the adoption of the built-up system places the Austrian army in the front rank in the matter of wireless telegraphy in the field.

CONTRACTS OPEN and CLOSED.

OPEN.

Blackrock (Co. Dublin). — September 22nd. The Main Drainage Board wants tenders for an electric power installation. See "Official Notices" September 7th.

Gillingham.—September 24th. Coal for the Corporation generating station. See "Official Notices" September 14th.

Isle of Thanet.—The Electric Tramways and Lighting Co. invite tenders for general stores. See "Official Notices" to-day.

Johannesburg.—October 15th. Tenders are required by the T.C. for single-phase A.C. motors with accessories. See "Official Notices" August 31st.

Limerick.—October 2nd. Gas plant, gas engine and dynamo, switchboard extensions and cables for the Corporation Electricity Department. See "Official Notices" September 14th.

Marylebone.—September 25th. Coal for the Council's electricity department for one year:—Scotch or Yorkshire washed nuts, Shipley and Griff peas.

Mersey Railway. — Tenders for stores and electrical sundries for one year. See page 422 last issue.

Netherlands.—September 29th. The Municipality of Utrecht invites tenders for the supply of: (1) 12 completely-fitted electric motors for the Utrecht electric tramways; and (2) the supply and erection of an overhead electric tramway system, with all accessories. Tenders to the Municipal Offices, Utrecht. Specifications, &c., may be obtained on payment of 5 francs (about 4s. 2d.).—*Board of Trade Journal.*

Southport.—September 29th. Electric motors, gas engines, pumps, &c., for the Corporation. See "Official Notices" September 14th.

CLOSED.

Algeria.—The Algerian Post and Telegraph authorities have just placed a contract with the Société Française de Constructions Mécaniques, of Belfort, for 3,750 metres of telephone cable.

Hove.—The T.C. on September 13th accepted the offer of the Reason Manufacturing Co. to supply on sale or return 12 tantalum metallic filament lamps and fittings for street lighting.

London.—St. Pancras.—The B.C. has received the following tenders:—

One 2,000-kw. Steam Turbo-Generator, with Switchboard, Condensing Plant, &c.

Willans & Robinson	(provisionally accepted)	£8,857
General Electric Co. (Richardsons-Westgarth turbine)		9,445
Do. (Willans turbine)		9,518
Siemens Bros. & Co. (Parsons turbine)		9,778
Do. (Richardsons-Westgarth turbine)		9,888
Do. (Willans turbine)		9,769
Richardsons, Westgarth & Co. (Dick-Kerr alternator)		9,870
Do. do. (Siemens alternator)		10,145
Electric Construction Co. (Parsons turbine)		9,875
Do. do. (Richardsons-Westgarth turbine)		9,780
Do. do. (Willans turbine)		9,725
Mather & Platt (Zoelly turbine)		9,940
C. A. Parsons & Co.		10,210
British Thomson-Houston Co. (Curtis turbine)		10,240
British Westinghouse Co. (Westinghouse turbine)		10,281
Brush Electrical Engineering Co. (Brush turbine)		11,075
Brown, Boveri & Co. (Richardsons-Westgarth turbine)		11,084
Electrical Co.		13,500

The Electricity Committee reported that in addition it was necessary in regard to the majority of the above tenders to add a provisional sum of £800 for the foundations, but in any case the tender of Messrs. Willans & Robinson was the lowest, and the chief electrical engineer had reported that he had every confidence, after inspecting a plant of nearly the same capacity supplied by this firm, in recommending the acceptance of their tender. He further stated that they undertook to supply in the shortest time of any of the firms quoting. The specification appointed the chief electrical engineer as sole arbitrator in case of dispute, but except in one case the tenderers asked for independent arbitration. The condition under which the Council accepted Messrs. Willans & Robinson's tender at £8,857, with the addition of a provisional sum of £800 for the foundations, was subject to their agreeing to Mr. Baynes, the Council's chief electrical engineer, acting as sole arbitrator, but in the event of his being unable so to act, to the substitution of the usual arbitration clause.

Two Three-Phase High-Pressure 500-kw. Motors for Sub-Stations, and One 1,000-kw. Motor for King's Road Station, with Switchboard, &c.

General Electric Co.	£4,763 10 0
Siemens Bros. & Co.	5,689 0 0
British Thomson-Houston Co.	5,723 0 0
Mather & Platt	5,739 0 0
Electrical Construction Co.	6,184 0 0
Bruce Peebles & Co.	6,840 0 0
Do. (alternative)	6,180 0 0
Vickers, Son & Maxim	7,200 0 0
British Westinghouse Co.	7,234 0 0
British Electric Plant Co.	7,450 0 0
Dick, Kerr & Co.	7,726 0 0
Electrical Co.	7,760 0 0
Brush Electrical Engineering Co.	8,710 0 0
Crompton & Co.	8,965 0 0
Brown, Boveri & Co.	9,912 0 0

The chief electrical engineer reported that a number of the foregoing firms had not included the cost of foundations, which he estimated at £450, and had also omitted to provide for the cables connecting the machinery to the switchboards, which he estimated at £200. He had, therefore, adjusted the six lowest tenders accordingly with the following results:—

General Electric Co.	£5,413 10 0
Bruce Peebles & Co. (provisionally accepted)	6,180 0 0
Siemens Bros. & Co.	6,339 0 0
British Thomson-Houston Co.	6,373 0 0
Mather & Platt	6,389 0 0
Electric Construction Co.	6,834 0 0
Vickers, Son & Maxim	7,850 0 0

The chief electrical engineer reported that after going carefully into the question of the efficiencies offered by the various firms, he considered the tender of Messrs. Bruce Peebles & Co., at £6,180, the most economical, and in this view the Electricity Committee concurred. The condition under which the Council accepted the tender of the firm named was that they should agree to a clause being inserted enabling the local authority to take a proportionate amount from the contract for every per cent. or fraction per cent. of efficiency below that specified in their tender, and also empowering the Council to reject the plant wholly if the percentage should fall below the following rates of efficiencies:—Combined efficiency of 1,000-kw. motor: full-load 90 per cent., ¾-load 87 per cent., ½-load 85 per cent; 500-kw. motors: full-load 89 per cent., ¾-load 87·5 per cent., ½-load 84 per cent. [Presumably for the word "motor" we must read "motor-generator."

City.—The contract for the electrical installation in the new out-patients' block of St. Bartholomew's Hospital, which is in course of erection, has been awarded to Messrs. Thompson, Ritchie and Co., Ltd. The accepted tender is in accordance with the specification of Mr. F. Charles Raphael, and includes the lighting of the block (about 900 lamps), wiring to the lift and fan motors, and the provision of the motor-generator and circuits for the medical applications of electricity.

Hammersmith.—The B.C. has placed an order with the British Electric Transformer Co. for 10 controlling boards of Berry series gear, at £35 per set.

Perth (W.A.).—Messrs. Thermit, Ltd., have received an order from Messrs. J. G. White & Co., Ltd., for one of their portable rail grinder machines (Mattinson's patent), for the Perth Electric Tramways, Ltd., Perth, W.A.

Salford.—The T.C. has accepted the following tenders :—

British Westinghouse Electric & Manufacturing Co.—Special car accessories.
Meters, Ltd.—Station meter.
W. T. Glover & Co., Ltd.—Paper-insulated cables.
Liverpool Electric Cable Co., Ltd.—Cables.
Howard Asphalt Troughing Co., Ltd.—Asphalt troughing and bridges.
Rowland Carr & Co.—Bitumen and bitumen compound.
Berry, Skinner & Co.—Switches and motor starters.
Everett, Edgcumbe & Co.—Gravity type ammeters.
Simplified Underground Conductor Co., Ltd.—Asphalt concrete.
Ferranti, Ltd.—House meters.
Adams Manufacturing Co., Ltd.—Motor starters.
Johnson & Phillips, Ltd.—Cables.
Electromotors, Ltd., and Royce, Ltd.—High and low speed motors.
General Electric Co.—Steel insulated screwed tubing.
British Insulated & Helsby Cables, Ltd.—House fuse boxes and mica sheets.
Lancashire Dynamo & Motor Co., Ltd.—Electric motors.

Stalybridge.—The Stalybridge Joint Tramway Board has decided to install a 2,000-kw. turbine set in its generating station, and has placed the complete contract, including turbine generator and condensing plant, in the hands of Messrs. Willans and Robinson, Ltd. The alternator, which is to be of the three-phase type, will be built by Messrs. Bruce Peebles & Co.

FORTHCOMING EVENTS.

Open to October 17th.—Engineering and Machinery Exhibition at Olympia, Kensington, W.

Tuesday, September 25th.—At 8 p.m. Electrical Contractors' Association (Inc.). At Frascati Restaurant. Mr. E. L. Berry on "A New Method of Employing Twin Lead-Covered Wire for Electric Light Wiring."

THE CAPACITY EFFECT IN WATER RESISTANCES.

In a recent number of the *E.T.Z.*, Herr Karl Wallin describes some useful tests on this subject carried out at the Stockholm Technical High School. It has often been suggested that liquid resistances used to absorb the load of alternators or transformers cannot safely be considered as working at a power factor of unity because of their electrostatic capacity. The following tests go to prove that though a capacity effect is present, it is quite negligible under ordinary circumstances. The resistances used were specially made for the tests, and consisted of two rectangular iron plates separated by means of a rubber-covered insulated wire bent into a U-shape and running round three sides of the plate. In this way a narrow vesse was formed into which any desired liquid could be put, and through which a current could be passed from one iron plate to the other. The liquid was kept running through the vessel, so that a steady temperature and resistance could be maintained. The surface of each plate in contact with the liquid was 4,300 sq. cm., and the average distance between the plates was ·6 cm. In each test the current flowing and the voltage between the plates were measured by standard meters, and at the same time the current and voltage curves were recorded by means of a Duddell oscillograph.

A large number of tests were carried out with water of varying degrees of purity and at varying current densities, and the three following examples indicate the sort of results obtained :—

Test No.	Oscillograph curves shown in :	Volts between plates.	Amperes.	Calculated specific resistance of liquid in ohms per cm. cube.	Current density in amperes per square metre.
1	Fig. 1	7·92	·1	567,000	·23
2	Fig. 2	113	2	404,000	4·65
3	Fig. 3	55	50	7,880	116

In order to obtain readings at higher current densities soda solutions were used, and densities up to as much as 1,000 amperes per square metre were obtained, the volt and ampere curves, however, remaining practically superposed as in fig. 3.

It is evident from these tests that, even under the especially favourable condition of a very small distance between the plates compared with their area, no noticeable phase displacement between the voltage and current occurs, and also no appreciable distortion of the current curve.

In the case of soda solutions, however, a distinct phase displacement could be produced, but only so long as the voltage employed was not much in excess of the dissociation voltage of the solution.

Some tests on this point were carried out with a three-plate resistance in which the middle plate acted as one electrode and had a surface of 220 sq. cm. in contact with the liquid, and the end plates (at a distance of only ·14 cm. from the middle plate) acted as the other electrode. These tests showed that though no phase displacement could be noticed with a ·5 per cent. soda solution, a considerable displacement occurred with 5 per cent., 10 per cent., or 15 per cent. solutions with a current of 20 amperes and 1·5 to ·9 volts. A remarkable fact noticed was the absence of all phase

Fig. 1.

Fig. 2.

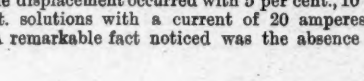


Fig 3.

displacement again at the highest attainable saturation of the solution (3 kg. of fused soda in 12 litres of boiling water). No change in this respect occurred even at the highest current densities (50,000 amperes per sq. metre). In those cases where a phase displacement was obtained, the liquid resistances did not behave quite like ordinary condensers, for the usual exaggeration of the higher harmonic waves in the current curves did not occur.

The experiments point clearly to the fact that for all practical cases (circuits of 100 volts or more) no capacity error whatever can be introduced by the use of liquid resistances consisting of iron plates in water or in soda solutions.

NOTES.

Review of Whittaker's Electrical Engineers' Pocket-Book.—The following reply from our Reviewer to a letter in our "Correspondence" columns arrived too late for inclusion there:—"Your reviewer expressly stated that even Hospitalier was not immaculate, in order to soften the force of the criticisms which it was his duty to make. On looking up p. 314 of Hospitalier he sees that an unnecessary 2 has got into one of the formulæ, but in the numerical example immediately underneath it the correct formula is used, and so the careful reader would not be misled. On p. 317 there are a lot of formulæ given, but without looking up a paper *published in* 1903, the reviewer cannot say whether they have been correctly copied or not. Anyhow, the errors in the one case are to the errors in the other as the cost of the sack to the bread in Falstaff's bill.

"The authors do not grasp the reviewer's point about the permeability of iron being large for small magnetising forces. It is an extraordinarily curious and important phenomenon (*vide* Rayleigh's 'Scientific Papers'). There is no 'of course' in connection with it. Because a quantity attains a maximum value, it does not follow that it is initially small.

"It is misleading to compare the semi-metaphysical criticisms of Euclid's axioms with the palpable error on p. 102. The current grows at the rate $(v - Rc)/L$ and not at the rate v/L, so long as the 'v volts act on the L henrys.' If we separate the L and the R, which is a physical impossibility, we can easily make up nonsensical theorems.

"The explanation of the 'skin effect,' although plausible, is wrong. The statement that a theoretical explanation may be clear to a practical man, but not to a mathematician, needs proof.

"In the above letter we are told that the pocket-book does not pretend to be a mathematical treatise, but this is no reason why it should give erroneous formulæ. The reviewer was not referring to three printers' errors on p. 127 when criticising that page, but to the formulæ themselves. He now learns that they are copied from the *Electrical World*, of New York, but this does not make them any more accurate. He always thought that the capacity of a ring was $\pi r/\log (8\ a/r)$, approximately, where a is the radius of the circular axis, and r the radius of the cross-section. The formula the authors give is πr. Your reviewer does not need to refer to the complete formulæ for the inductance of rods terminated by small square plates for the simple reason that

no such formulæ have ever been calculated by a mathematician. The formulæ are what the French call 'shocking.' Fancy giving a formula for the self-inductance of two equal spheres and stating that their capacity equals the radius of either!—Your Reviewer."

Radiation from Gas Mantles.—In a paper read before Section A of the British Association, Mr. J. Swinburne discussed the current theories put forward to explain the great luminous efficiency of the gas mantle. One is that rare earths have a property of selective radiation, in virtue of which they send out a larger proportion of their radiant energy in the form of light than ordinary hot bodies. Another is that the Bunsen flame is really very hot, and that the mantle is of such low emissivity that it gets rid of so little power that there is little difference of temperature between it and the flame, and it is therefore hot enough to give the light by pure temperature radiation, without any anomaly. One reason why the simple temperature explanation has been much questioned, and generally rejected, is that the temperature of the Bunsen is generally taken to be much lower than it is.

"The simple temperature explanation fits the phenomena. If pure thoria has low emissivity it will rise to a temperature near that of the shell of flame bathing it. Having low emissivity it will then give out little light, but the light will have a larger proportion of visible and refrangible rays. If a very little of a body with a high emissivity be added, radiation will increase, but the temperature of the mantle will fall, as there must be a steeper heat gradient to supply it. The total radiation is then increased, and though the proportion which is luminous will be diminished, the total light will be increased. Further addition of the emissive substance increases the total radiation and reduces the temperature until the light given is less even than with pure thoria."

"The reason why ceria is used is not that it has any peculiar radiating qualities; it is chosen because it is fairly permanent at the high temperatures, and does not weaken or spoil the thoria mantle."

"Though this simple explanation may be ample, it does not follow that there may not be all sorts of curious things, such as selective emission, luminescence, catalytic action, resonance, unstable oxidation, and other occurrences, whose names are as impressive as vague."

The author discusses these in turn, and dealing with a suggested function of the ceria, whereby it acts as an oxygen carrier and aids combustion, he says:—

"As an analogy we may consider a matrimonial agency, with a number of women on its books. Any man knocking about who comes there meets a wife at once and combines, or is burnt at once, whereas, had he merely knocked about until he met a suitable wife, the probability is that he would have been longer about it. In a stationary population of immortal Americans, the state of equilibrium (with the maximum degradation) would be reached when the marriage and divorce were equal. A matrimonial agency, like a true catalist, would then have no effect on the state of equilibrium. This is really only the catalytic theory again, looked at from a molecular point of view."

He concludes: "The explanation that there is nothing anomalous about the mantle, and that it gives light just because it is very hot has a Jordan simplicity about it which makes it unpopular compared with the Abana and Pharpar of luminescence and catalytic action; but, all the same, very simple explanations are very often wrong."

Fatality.—At York electricity works on the 12th inst., a labourer named Laycock was killed while employed by Messrs. Manlove, Alliot & Co., Ltd., in demolishing the main flue of the destructor. It appears that the deceased was standing between the brick wall of the flue and the wall of the destructor building, engaged in unscrewing the bolts of the clamps which keep the flue secure, and had just got the bolts loosened, when the brick wall of the flue gave way, and, falling outward, pinned the unfortunate man to the wall of the destructor.

The Gas Turbine.—An article by Dr. C. E. Lucke, a pioneer in the gas turbine field, is published in the *Engineering Magazine* for August, in which the author discusses the feasibility of the turbine, and protests against the protracted discussions between writers on the subject where only individual opinions, and not experimental results, are concerned. He has himself carried out experiments on the temperature drop in a De Laval turbine, driven for the purpose by compressed air, and has found that the actual fall obtained is only a small percentage of the theoretical adiabatic fall, indicating that there is very little conversion of heat into work in the course of free expansion in nozzles, and that, therefore, such expansion is very inefficient. The result is corroborated by the author's inquiries of many eminent experimenters in the same direction. A number of questions addressed to engineers interested in the subject of gas turbines elicited replies from some of which we quote:—

Prof. R. C. Carpenter said: "Respecting the future commercial success of the gas turbine, I would state that I have formed an opinion which is unfavourable, due to the extremely high temperature which the working parts must be subjected to. Quite a number of experiments respecting the gas turbine have been carried on in our laboratory during the past eight or ten years. I felt at first that the machine could be made a practical success, but latterly I have concluded that the practical difficulties were nearly unsurmountable."

Prof. S. A. Reeve, concerning the prospects of overcoming the difficulties, said: "The prospects are excellent. . . . . The usual period for the experimental development of a solution of the problem of building old devices along new lines is all that intervenes between the present and a practicable gas turbine. . . . The compressor is the only unsolved and difficult part of the problem."

Prof. W. T. Magruder believed the difficulties would be overcome, and was not prepared to say that compression was absolutely necessary.

Mr. F. E. Junge said the prospects were good if the efficiency of the proposed turbine was a secondary consideration; he saw no difficulty in the compression, but spoke of the "impossibility" of finding proper material to stand the high temperatures continuously, a phrase which discounts his reference to good prospects.

Prof. Elihu Thomson was not prepared to disclose data obtained by the General Electric Co.; he saw no theoretical impossibility in the gas turbine, but considered the practical problems of great difficulty, especially that of compression.

Mr. W. L. R. Emmet, who had taken up and abandoned the subject several years ago, thought that it offered "a less attractive field for development than many others to which a competent engineer might devote his energies."

The author concludes that the practical gas turbine is a long way off, and we regretfully concur in this view.

Milan Tramways Congress. — The International Union of Tramways and Light Railways ends to-day its annual congress at Milan. It was opened on the 17th inst. by the Italian Minister of Public Works, and on that day M. Ch. Thouet presented for Prof. Eric Gérard, who was unable to be present, a paper dealing with electric traction on light railways. This was followed by a report from M. E. A. Ziffer on the economic importance of producer gas plants in relation to tramways. M. Ziffer has been prominent as a reporter on other occasions.

On the second day there were three papers during the day, and another by Signor G. Semenza on "The Applications of Steam Turbines to Electric Traction," during a reception by the Italian Edison Co. in the evening. M. Géron read his report on "The Design of Tramcars," with special reference to their width; MM. Piazzoli and G. Rasch compared the systems of feeding an important network with or without divisions; and Mr. Kapp presented in the names of MM. Rasch, Blondel, d'Hoop, McCloskie, Swinburne and Wyssling a scheme for standardising direct-current motors. Two papers on "Permanent Way," and a third, appropriately enough, by M. Watt-Mann, on "The Results obtained from the Use of Meters on Tramcars," occupied the third day; while to-day is to be given up to reports on the various brakes in use on electric tramways, by MM. Petit and Scholtes, and on the maximum speeds of trains on light railways by M. E. Krasa.

In a future issue we hope to give our readers some idea of what the papers contained.

Prospects in New Zealand.—From a correspondent in New Zealand we have received an extract from a Wellington paper which reads as follows:—

"Inquiries made of the Department of Labour go to show that the electrical engineer has become somewhat of a drug on the market. Apparently he has gathered in the Old Country that New Zealand is busily engaged in illuminating and propelling itself by means of electricity, and he has come out here to offer his services in the process. Now he finds that he is not in such demand as he thought; and he is looking eagerly for that which he thought would be thrust upon him."

Our correspondent adds that others in the profession who, like himself, are liable to be led astray by the exaggerated accounts of New Zealand's prosperity, should take note of the above.

Electric Shock.—It is reported that an engineer named George Platt, engaged at the Warrington Corporation electric station, and residing at Martinscroft, received a shock at 6,000 volts from one of the generators, and was badly burned. He was taken to the infirmary.

Killing the Dust.—The Brooklyn Rapid Transit Co. has found the sandy dust of its suburban surface lines so objectionable that it is trying to overcome the trouble by sprinkling the very lowest grade crude oil direct from the railway tank wagons over the tracks. The results are said to have been very satisfactory, as the oil, which contains a great deal of asphalt products, cements the dust and sand into a semi-solid mass, from which particles cannot be whirled by trains passing at high speed. The cost of the oil is about 3 cents per gallon, and 4,000 gallons per mile of double track have been used. The *Street Railway Journal* for September contains illustrations of the simple apparatus in use, but the article does not state how frequently the road has to be treated to keep the dust down permanently.

The Liability of Contractors.—At the weekly meeting of the Tramways and Electricity Committee of Belfast Corporation, on the 17th inst., the city surveyor, Mr. Cutler, made a report with regard to the time occupied by Messrs. J. G. White & Co., Ltd., London, on the construction of the permanent way. From this it appeared that the firm undertook to do the day work in nine months, and the time actually taken exceeded that limit by 36 days. The contractors were liable to a penalty of £1,000 per day over the contract period. Of that period, 26 days were lost owing to "stress of weather," and 14½ days by strikes. Taking everything into consideration, the surveyor could not see that the penalty of £1,000 per day could be enforced.

South Africa.—A course of lectures on "The Application of Electrical Methods to Chemistry" is being given by Prof. Lehfeldt at the Transvaal University College, Johannesburg.

Electro-Harmonic Society.—Arrangements have been made to hold the Society's concerts for the ensuing season in the King's Hall, Holborn Restaurant, on the following Friday evenings:—Smoking concerts: October 5th and December 14th, 1906; January 11th and April 19th, 1907. Ladies' nights: Concerts will be held on November 9th, 1906, and February 22nd, 1907. Members can now obtain their season tickets, which provide admission for one friend also to each concert, upon application to the hon. sec., Mr. W. E. Lane, Finsbury Pavement House, E.C. The annual subscription is 10s. 6d., and is payable previous to the first concert of the season.

P. & O. Batti-Wallahs' Society.—On Thursday last week the P. & O. Batti-Wallahs' Society, with the kind consent of the managing directors of the P. &. O. S.N. Co., visited one of their latest ships, the ss. *Mooltan*, at Tilbury Docks. The members travelled by special saloon to the docks, arriving about 2.50 p.m. They were received by the chief engineer, who asked the electrician attached to the ship to show the members round. A tour of the engine room was made, and all were much struck to see the great advancement that the P. & O. Co. had made in their electrical equipments. The plant installed consisted of five two-crank engines coupled up to four-pole dynamos of the Siemens-Belliss & Morcom combination, and one smaller generating set placed on the upper deck, with a small donkey boiler for emergency use. The wiring for the upper decks is connected to the main board through a branch board in the emergency engine room, thus arranging for lights on the upper decks should the main engine room be flooded through mishap. The five main sets generate each 350 amperes at 105 volts, the low voltage being the only unchanged feature since the days when the older members were at sea. Two sets feed the motor circuits, two the lighting circuits and one is spare. The ammeters, starting switches and speed regulators for the many motor circuits were the first means of bringing home to the members the fact that a great change had taken place. The five forced-draught fans were driven by electric motors, as were two large fans ventilating the engine room, and many applications of electricity were seen in different parts of the ship. A large number of cabins were provided with small electric fans, and in the pantry and galleys very interesting examples were seen, such as an electric motor for turning the spit in the roasting ovens, and also electric plate and dish washing machines. In the saloon were a large number of electric punkahs fitted up, and these are, no doubt, much appreciated in the tropics and preferred to the old hand-pulled punkahs of the earlier days. An electric telephone system has been introduced enabling the officer on the bridge to speak to either the engineer of the watch, the look-out forward, or the officer on the poop (while mooring.) Before leaving, the visitors were entertained to tea in the saloon, and all expressed great satisfaction at the admirable arrangements made by the P. and O. Co. for their reception.

The Thury System.—The *Times* (Engineering Supplement) says:—"It is understood that the sole rights for this country and certain others for the Thury system of electrical transmission have been acquired by Messrs. Dick, Kerr & Co., Ltd. It will be remembered that the Thury system was regarded as a material element of the success which was anticipated by its promoters for the Victoria Falls electrical transmission scheme. Messrs. Dick, Kerr & Co., Ltd., there is reason to believe, are on the point of utilising the Thury direct-current system in several directions. In the meantime, the direct-current system first proposed for the electrification of the Victoria Falls has been replaced by three-phase alternating."

Electric Shock Fatalities.—On the 11th inst. an inquest was held concerning the death of Gilbert Edwards, a signal fitter employed by the District Railway, who died from injuries received by accidental contact with the third rail. Edwards was at work near the Mansion House Station before daylight on 5th inst., when his spanner came into contact with the live rail, and a current at several hundred volts passed through his body. He died at St. Bartholomew's Hospital on the following Saturday after stating to his relatives that the accident would not have occurred if the current had not been turned on half-an-hour ahead of time. Evidence was produced to show that the current was turned on at 4.30 a.m., the regular time, and that Edwards was at work just before this. If the man's spanner had not slipped no harm would have come to him. In returning a verdict of "Accidental death," the jury added a rider to the effect that "in their opinion the District Railway Co. should adopt some means of giving warning to the men employed on their line a few minutes before the turning on of the electric current."

One day last week at the Brimsdown power station two men received electric shocks while repairing a cable. One of them, by name James Winepress, was killed, the other being seriously injured.

Unfair Preference.—At a recent meeting of the Bolton Town Council it was stated, in connection with the acceptance of a tender for supplying two Lancashire boilers, that the firm whose tender (not the lowest) was accepted was approached with a view to obtaining a reduction of the tender; the other firms, however, were not given an opportunity to reduce their tenders, and it was said that a local firm refused to tender on account of preference given to another local firm which always got the work. It appeared that ten other firms tendered at a lower price than the Bolton firm, and the latter, when requested, took off £100 (7½ per cent.). An attempt was made to have the question reopened, and was supported by 29 members, but 34 opposed it, and the movement failed. Strong remarks were made as to the unfairness and immorality of the procedure adopted, and it was urged that if the Committee was satisfied that only one firm could do the work, the others should not have been put to the expense of tendering. It was clear that the object of the Committee was to retain the work in Bolton, and equally clear that the method adopted to gain this end was highly discreditable to the Corporation. Unfortunately, the recognition of moral obligations and good faith are not characteristic features of municipal trading.

Scott's Old Boys.—The second annual re-union dinner will be held at the Manchester Hotel, Aldersgate Street, on October 6th, at 6.30 p.m., for 7 o'clock. The scheme for an annual re-union has been taken up with enthusiasm, and a large number will be present. All who were trained or engaged in Scott's Engineering Works at Hammersmith or Acton are cordially invited. Anyone not having received a notice should communicate with the hon. sec., Mr. H. Marryat, 28, Hatton Garden, E.C.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* Electrical Review *posted as to their movements.

Central Station Engineers.—The Bradford T.C. has appointed Mr. John Wm. Dawson as assistant electrical engineer to the tramways department, at a commencing salary of £175 per annum, with an increase to £200 at the end of a year.

The Edinburgh Electric Lighting Committee has agreed to recommend that the mains superintendent be voted an honorarium of £50 in recognition of a labour-saving device for lamp cleaning devised by him.

The Worksop U.D.C. has increased the salary of Mr. J. P. Crowther, electrical engineer, to £200 per annum, rising by £25 a year to £300.

At the meeting of the South Shields Town Council on the 12th. inst the Electrical Committee recommended that the salary of the electrical engineer (Mr. J. H. Cawthra) be increased from £500 per annum to £550, rising by annual increments to £700. In moving the adoption of the report, Alderman Rennoldson referred to Mr. Cawthra's ability and assiduity, and thought the application was fully justified. An amendment that the matter be deferred for three months, and one that Mr. Cawthra's salary be increased by £25, were both defeated, and the recommendation of the Committee was agreed to.

Mr. Wm. Allen, A.M.I.E.E., is resigning his position as engineer-in-charge under the Gloucester Corporation, having been appointed chief assistant electrical engineer to the borough of Mansfield. He will take up his new duties next week.

Mr. R. H. Wilson, third engineer at the Chesterfield Corporation Electricity Works, was on Friday last presented by the staff with a silver cigarette case and pipe with amber mouthpiece, on the occasion of his leaving to take up the duties of chief assistant to the Lewes Electric Supply Co. Mr. R. L. Acland, who made the presentation, recalled the fact that this was the fourth occasion during the past 12 months on which a member of his staff had obtained the post of chief assistant engineer to an electric supply undertaking, in three of which the lighting and tramways were combined.

General.—We are asked to announce for the information of our engineering readers that the wife of Mr. John A. Smeeton, of London and Manchester, passed away on September 8th, at Staines, after acute suffering from appendicitis.

Mr. H. C. Jenkins, of the British Westinghouse Co., Trafford Park, has been transferred to the Sheffield office of the company as salesman.

A South African correspondent says that on August 24th an unfortunate accident happened whereby Mr. T. Parker, electrical engineer at Port Elizabeth, has lost the sight of one eye and will have to undergo a serious operation. Mr. Parker was driving along Main Street, where the tram-rails are now being laid, when he was struck in the right eye by a piece of metal chipped off one of the rails.

NEW COMPANIES REGISTERED.

Patent Appliances Syndicate, Ltd. (90,047).—This company was registered on September 4th, with a capital of £500 in £1 shares, to acquire the benefit of certain existing inventions relating to a self-charging electric battery and improved method for the production of air gas, and to develop and turn to account the same, &c. The first subscribers (each with one share) are:—J. Phillips, 193, Lambeth Walk, S.E., boot factor; G. Petrides, 29, FitzJames Avenue, West Kensington, merchant; W. Moores, 14, Leckford Place, Brixton, S.W., engineer; Mrs. L. Phillips, 88, Sternhold Avenue, Streatham Hill, S.W.; M. Fabre, 88, Sternhold Avenue, Streatham Hill, professor of languages; Mrs. E. I. Petrides, 29, FitzJames Avenue, West Kensington; and F. R. Pate, 103, Powerscroft Road, Clapton, N.E., accountant. No initial public issue; registered without articles of association.

Pilkington & Gibbs, Ltd. (90,072).—This company was registered on September 7th, with a capital of £5,000 in £1 shares, to carry on the business of engineers, dealers in machinery and manufactured articles (excepting in Great Britain, steam and power hammers), cotton machinery manufacturers, ironmasters, founders, metal-workers, tinplate makers, electric cable manufacturers, electrical engineers, coppersmiths, electricians, &c. The first subscribers (each with one share) are:—W. R. Pilkington, Dowry House, Bamber Bridge, near Preston, engineer; G. J. Gibbs, Brownedge, Bamber Bridge, near Preston, engineer; A. C. M. Lillie, 23, Osborne Terrace, Bamber Bridge, near Preston, draughtsman; B. Hansom, Albert Square, Fleetwood, engineer; F. J. Chesters, 18, Broadgate, Preston, clerk; A. E. W. Gwyn, 37, Culmington Road, Ealing, W.; and J. L. Bertwistle, The Limes, Appleby, brewer. No initial public issue. The number of directors is not to be less than two or more than five; the first are W. R. Pilkington and G. J. Gibbs (permanent governing directors); qualification of governing directors, 500 shares; of others, £200 shares or stock; remuneration as fixed by the company (subject to any agreement). Registered offices, 7, Lime Street, Preston.

Christy Brothers & Co., Ltd. (90,039).—This company was registered on September 3rd, with a capital of £12,000 in £1 shares (3,000 deferred), to acquire the business carried on at Chelmsford, by Christy Brothers and Middleton, to adopt an agreement with F. Christy, L. F. Christy and W. Middleton, and to carry on the business of civil, mechanical, electrical, hydraulic, consulting and contracting engineers, ironmasters, iron and steel manufacturers and founders, &c. The first subscribers (each with one share) are:—F. Christy, 53, Broomfield Road, Chelmsford, electrical engineer; L. F. Christy, 51, Broomfield Road, Chelmsford, electrical engineer; W. C. Christy, 54, Broomfield Road, Chelmsford, engineer; G. H. Balls, "Dinmore," Broomfield, electrical engineer; W. Rishworth, Kirk Ella, Hull, electrical engineer; E. Hockley, Maddow Road, Chelmsford, works foreman; and F. W. Taylor, Chelmsford, auctioneer. No initial public issue. F. Christy and L. F. Christy are governing directors, and each may retain office while holding between them 5,000 shares; remuneration, £400 and £300 per annum respectively.

Sevenoaks Motor-car and Electrical Co., Ltd. (90,070).—This company was registered on September 6th, with a capital of £6,000 in £1 shares (2,000 4 per cent. cumulative preference), to carry on the business of motor-car, cycle and vehicle manufacturers, storers and dealers, electrical and general engineers, &c. The first subscribers (each with one share) are:—Capt. H. Fulton, Lisburn, Sevenoaks; J. Fulton, Lisburn, Sevenoaks; Miss I. L. Heany, Lisburn, Sevenoaks; A. Whitehead, London Road, Sevenoaks, engineer; Mrs. A. E. Whitehead, London Road, Sevenoaks; Miss E. Whitehead, Riverhead, Sevenoaks; and A. E. Hasemore, 91, Lavender Hill, Tonbridge, clerk. No initial public issue. The number of directors is not to be less than two or more than seven; the first are H. Fulton (permanent chairman) and A. Whitehead; qualification, £100; remuneration as fixed by the company. Registered office, Tubs Hill, Sevenoaks, Kent.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electrical Turnery, Ltd. (London) (79,195).—A 5 per cent. debenture, dated August 31st, 1906, to secure £322 14s. 1d., charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holder: H. H. Sanders, 10, Windmill Street, W.C.

Uxbridge and District Electric Supply Co., Ltd. (62,706).—Issue on August 31st of £1,600 6 per cent. debentures, part of series created July 10th, 1906, to secure £15,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series: £9,400.

CITY NOTES.

Malaga Electricity Co., Ltd.

The directors' report to December, 1905, says that the sale of current produced Ptas. 254,972·48 for 1905, as against Ptas. 255,508·41 for 1904, showing a decrease of Ptas. 535·93. The total income from all sources amounted to Ptas. 335,920·99 in 1905, as against Ptas. 334,970·47 in 1904, showing an increase of Ptas. 950·52. The expenditure has increased from Ptas. 215,921·62 in 1904 to Ptas. 259,029·26 in 1905, a difference of Ptas. 43,107·64. The number of 8-c.p. lights has increased from 26,466 in 1904 to 27,187 in 1905. The number of customers has also increased from 3,280 to 3,478. The profit, apart from any depreciation, has decreased from £3,189 to £2,175. This amount has been used for the purposes of depreciation, and there is a balance to carry forward of £47, against a balance last year of £36. The additional capital expenditure in 1905 has been £1,731, expended as follows:—Laying of mains and overhead wires, £754 12s.; installations, £642 15s.; transformers, £77 14s.; new water supply, £87 19s.; meters, &c., £167 18s. = £1,730 18s. The diminution in the profit of 1905, as compared with 1904, is due to:—(*a*) Increased taxation; (*b*) the company having to give a day-load in order to meet the German competition. This item alone accounts for more than half the difference in profits between the two years. It is impossible to avoid running during the day, since competitors do so, but Malaga at present is not large enough to provide a paying load for two companies; (*c*) the annual festivities not being held on account of the heavy loss due to the severe drought experienced by the whole of the South of Spain.

Mr. E. Crawshaw, the engineer at Malaga, reports that the steam plants, including boilers and engines, are in good working condition, as are also the generators and the electrical equipment. "The poor-gas plant is running daily 14 to 16 hours most satisfactorily, and, although it is not yet a paying day-load, there is in this year (1906) a great improvement over last year. Unfortunately again this year, owing to drought, the water-power has had to be cut off since June 26th, and our steam plants have had to take the load, and must continue to do so until next October, but we expect that by then the new reserve steam plant will be ready, and the water-power company will have a complete steam plant of the most modern type ready to switch on to their customers' mains in the case of any breakdown of the water-power, so that, although 1906 will be an improvement on 1905, there is a still brighter look-out for future years."

Dick, Kerr & Co., Ltd.

The report for the year ended June 30th last, to be submitted to the meeting on the 27th inst., states that the profits earned during the twelvemonths' trading amount to £86,354. Out of this had to be paid debenture and loan interest and trustees' fees, and there has been reserved the sum required to provide for the premium payable on the redemption of the present debenture stock. These items absorb £13,365, leaving a balance of £72,989, to which must be added the profits brought forward from last year, namely, £42,388, making a total of £115,377. The directors propose to carry to special reserve for extensions of manufactories or replacements of machinery, &c., or special depreciation of same (referred to below), £15,000; to pay a dividend of 10 per cent. on the ordinary shares, and to carry forward £56,077. During the year the company has been fully employed on important contracts, both at home and abroad, and the manufacturing departments have been kept busy. Last year attention was drawn to the severe competition existing in all branches of the business, and the directors regret to say there is no improvement in this direction. In the last balance-sheet there was shown a special reserve of £40,000 to be set aside for the purposes of extensions of manufactories, replacements of machinery, &c., or special depreciation of the same. The directors now propose to make a net addition of £10,000 to this reserve, bringing the total to £50,000, in addition to which £5,000 has been written off tools, &c.—*Financial Times.*

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in and to grant a quotation to—

Lisbon Electric Tramways, Ltd.—Further issue of £100,000 ordinary shares of £1 each.

To appoint a special settling day in—

United River Plate Telephone Co., Ltd.—Further issue of 20,000 ordinary shares of £5 each, fully and £2 10s. paid, Nos. 80,001 to 100,000.

And to allow the following securities to be quoted in the Official List:—

Calcutta Tramways, Co., Ltd.—29,330 5 per cent. cumulative preference shares of £5 each, fully paid.

Hastings and District Electric Tramways Co., Ltd.—27,474 ordinary shares of £5 each, fully paid, Nos. 50,001 to 77,474 and 40,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 40,000.

The Committee has ordered the undermentioned to be quoted in the Official List:—

Folkestone Electricity Supply Co., Ltd.—Further issue of £15,000 4½ per cent. first debenture stock.

Prospectus.—*The Mabira Forest (Uganda) Rubber Co., Ltd.*—This company has been before the public with an issue of 93,998 £1 shares. It is to acquire a lease of the Mabira Forest, on the west bank of the Victoria Nile, for rubber plantation and other purposes. The forest has an area of 150 square miles, and the number of indigenous rubber-yielding trees of the Funtumia elastica species is estimated at nearly two millions, one half or more of which are said to be suitable for immediate tapping.

Geneva Tramways Co., Ltd.—At an extraordinary general meeting held in London last week, the Hon. A. G. Brand presiding, resolutions were passed approving a scheme for selling the undertaking to a new company and winding up the old one.

Sao Paulo Tramway, Light and Power Co., Ltd.—The directors have declared a quarterly dividend of 2 per cent.

Primitiva Gas and Electric Light Co. of Buenos Aires.—An interim dividend has been declared on the ordinary shares at the rate of 5 per cent. per annum (2s. 6d. per share) for the half-year ended June 30th last.

Armstrong, Whitworth & Co., Ltd.—The directors have declared a dividend on the ordinary shares at the rate of 20 per cent. per annum for the past half-year, carrying forward £103,869.

Halifax and Bermudas Cable Co., Ltd.—Further dividend of 2½ per cent., making 5 per cent. for the past year, carrying forward £774.

Direct West India Cable Co., Ltd.—Further dividend of 3 per cent., making a total of 6 per cent. for the past year, carrying forward £1,313.

Eastern Telegraph Co., Ltd.—An interim dividend of 1¼ per cent. on ordinary stock has been declared for quarter ended June 30th.

British Thomson-Houston Co., Ltd.—The report is published, just has we go to press, for the year ended March 31st last. The available profit of £33,245 has been applied to various depreciations. We shall print the report next week.

MARKET QUOTATIONS.

Wednesday, September 19th.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal)	per ton	£33 10	..
a ,, ,,	per ton	£30	..
a Bleaching powder	per ton	£5 10	..
a Bisulphide of Carbon	per ton	£18	..
a Borax	per ton	£15	..
a Benzole (90 %)	per gal.	10½d.	..
a ,, (50 %)	per gal.	10d.	..
a Copper Sulphate	per ton	£26	..
a Lead, Nitrate	per ton	£28	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90 % at 160° C)	per gal.	5/6	..
a Potassium Bichromate, in casks	per lb.	5¼d.	..
a Potash, Caustic (75/80 %)	per ton	£20	..
a Potassium Cyanide	per lb.	8¾d.	1¼d. inc.
a Shellac	per cwt.	230/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	..
a ,, Crystals	per ton	£8 5	..
a Sodium Bichromate, casks	per lb.	2¾d.	..
a ,, Cyanide	per lb.	7½d.	½d. inc.
METALS, &c.			
b Aluminium Ingots, in ton lots	per ton	£200	..
b ,, Wire, in ton lots	per ton	£220	..
b ,, Sheet, in ton lots	per ton	£210	..
b Babbitt's metal ingots	per ton	£43 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	9½d.	¼d. inc.
c ,, Tube (brazed)	per lb.	10¾d.	¼d. inc.
c ,, ,, (solid drawn)	per lb.	10¾d.	¼d. inc.
c ,, Wire, basis	per lb.	9½d.	..
c Copper Tubes (brazed)	per lb.	1/0½	¼d. inc.
c ,, ,, (solid drawn)	per lb.	1/0½	¼d. inc.
g Copper Bars (best selected)	per ton	£101	£2 inc.
g Copper Sheet	per ton	£101	£2 inc.
g ,, Rod	per ton	£101	£2 inc.
c ,, (Electrolytic) Bars	per ton	£94	£2 inc.
c ,, ,, Sheets	per ton	£106	£2 inc.
c ,, ,, Rod	per ton	£97	£2 inc.
c ,, ,, H.C. Wire	per lb.	11⅛d.	⅜d. inc.
f Ebonite Rod	per lb.	8/8	..
,, Sheet	per lb.	8/-	..
n German Silver Wire	per lb.	1/7	..
h Gutta-percha, fine	per lb.	6/- to 7/-	..
h India-rubber, Para fine	per lb.	5/1½ to 5/1⅝	dec.
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	54/5	½d. inc.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8	per ton	£9 15	..
g Lead, English Ingot	per ton	£18 15 to £18 17 6	12/6 inc.
g ,, ,, Sheet	per ton	£20 15 to £20 17 6	12/6 inc.
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£7	..
d Mica (in original cases) small	per lb.	6d. to 1/-	..
d ,, ,, medium	per lb.	2/6 to 4/-	..
d ,, ,, large	per lb.	4/6 to 8/6	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/3	..
p ,, rolled bars & rods	per lb.	1/1½ to 1/3	..
p ,, ,, strip & sheet	per lb.	1/4	..
o Platinum	per oz.	nominal	..
e Silicium Bronze Wire	per lb.	1/- to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
,, ,, in bars		£15 to £40	..
g Tin, Block (English)	per ton	£183 10 to £184 10	..
n ,, Wire, Nos. 1 to 16	per lb.	2/3	..
p White Anti-friction Metals—			
"White Ant" brand	per ton	£46 to £70	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£32	..

Quotations supplied by:—

a G. Boor & Co.
b The British Aluminium Co., Ltd.
c Thos. Bolton & Sons, Ltd.
d F. Wiggins & Sons.
e Frederick Smith & Co.
f India-Rubber, G.P. and Teleg. Works Co., Ltd.
g James & Shakspeare.
h Edward Till & Co.
i Bolling & Lowe.
k Morris Ashby, Ltd.
m W. T. Glover & Co., Ltd.
n P. Ormiston & Sons.
o Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Co., Ltd.

Llandudno and District Electric Tramway Construction Co., Ltd.—Mr. Chas. H. Rigg, presided at the statutory meeting of this company held at 13, St. Helen's Place, E.C., on 17th inst. In an address to the shareholders he stated that the directors were advised that the line would be finished and running by Easter next year. The contractors, Messrs. Bruce Peebles & Co., Ltd., had undertaken to pay a dividend at the rate of 6 per cent. per annum up to June 30th, 1907, on the subscribed shares, after allowing for any profits of the company for the period antecedent to that date available for dividend on such shares.

STOCKS AND SHARES.

Tuesday Evening.

Markets are mainly inanimate and languid. Every day some fresh member whose business is connected with investment stocks succumbs to the prevailing impression, that nothing like this depression has ever been seen in the course of his Stock Exchange career. Several offices we know where staffs have received an additional few days' holiday for the reason that there is not sufficient work to keep everyone employed; the clerks are sent off one or two at a time, for extra holidays. A rush of prospectuses is talked about as likely to come next month, and the usual hope deferred looks forward to October for the salvation of business.

One of the features is the flatness of District stock, a hint as to what might happen having been given here last week. The various mass meetings to protest against the revised scale of fares will probably injure the company in its season-ticket receipts; it is not likely that the ordinary daily revenue will be much affected. Metropolitan Consolidated has been flat also, the price dropping to 61. This is due to the continuance of the poor traffic returns. Trials were run last week at Park Royal of some of the most important machinery to be used in generating the electric current which will be supplied to sub-stations on the Metropolitan-Great Western section to Hammersmith, and the work should be finished certainly before another month is out. For Central London Ordinary stock to have dropped a point to 85 is rather surprising, in view of the District rebellion. City and South London remains dull, but a rise of two points lifts Waterloo and City to 104½, upon the approach of the time for the company's complete absorption by the London and South-Western. By the way, the stocks of the latter railway have not benefited at all by the Wimbledon and East Ham meetings.

Electricity Supply shares exhibit more of that declining tendency to which attention has already been drawn this month. City of London's are down to 10½, so, perhaps, the people who ran up the price preparatory to selling, have now disposed of their shares. Charing Cross Ordinary are lower at 4⅜. St. James's at 11 are 10s. easier, and a drop of ¼ in Metropolitans brings the price to 8½. The only alteration caused by dividend deduction is the loss of ½ in Chelsea Ordinary. Oxford shares, *ex* 2s. 6d. remain at 6½. Debenture stocks are colourless.

Speculation in Anglo-Americans seems to have taken up all the time and attention of the Telegraph section, because there is hardly a movement in anything else. The Anglo group has hardened—appreciably in the case of the Deferred. Trust companies' securities are equally motionless, nor is there any change in the prices of the National Telephone list. Indo-Europeans put on 15s. to 60½, a buyer finding that there were no shares in the market.

Some few manufacturing shares are a little lower. Noticeably, there are falls of 1/16 in Brush Ordinary, and of ⅛ in the Preference, of ¼ in Edison & Swan fully paid "A" shares—making the price 2¼—and of ⅛ in Henley's Preference. But Henley's Debenture has regained the ½ it lately shed. There is firmness to be found in Babcock & Wilcox at 4⅜ and in British Aluminium at 4.

London United Tramways Debenture shed a point, and British Electric Traction Preference went down 2s. 6d. to 9½. Anglo-Argentine Trams are steady, and the same description applies to the other stocks in this section.

Compagnie Française des Câbles Télégraphiques.—The gross receipts of this cable company in 1905 amounted to 6,800,000 fr., as compared with 5,519,000 fr. in the preceding year. On the other hand, the expenses reached 6,521,000 fr. as contrasted with 6,859,000 fr. in 1904. The figures show a profit of 279,000 fr. for 1905, as against a loss of 1,340,000 fr. in the previous year. Notwithstanding the more favourable results the directors informed the shareholders at the last meeting that the position of the company remained difficult on account of the old cables needing to be improved, while the disputes with Venezuela and St. Domingo had not been settled. The company has a share capital of 13,430,000 fr., and obligations amounting to over 47,900,000 fr. in circulation.

Direct Spanish Telegraph Co., Ltd.—The board has decided to pay in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent. per annum, free of income-tax, on the ordinary shares, both for the half-year ended June 30th, 1906, and payable on October 1st next.

City of Buenos Ayres Tramways Co., Ltd.—According to the *Financial Times*, a further distribution of 5s. per share will be made by the liquidators on and after 1st. prox.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last four years. 1902.	1903.	1904.	1905.	Closing Quotations Sept. 11th.	Closing Quotations Sept. 18th.	Business done week ended Sept. 18th, 1906. Highest	Lowest.	Rise + or Fall —
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3⅛ — 4	3⅛ — 4	..	..	..
155,500	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	5 %	87 — 92	87 — 92	..	..	..
702,600	Anglo-American Telegraph	Stock	60/6	61s.	2¾%	3½%	66 — 68	66¼ — 68¼	..	..	+ ¼
3,148,700	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5¼%	6 %	113¾—114¼	113⅞—114⅛	114⅛	113⅞	..
3,148,700	Do. do. do. Deferred	Stock	1/-	2s.	Nil	¼%	23⅝ — 23⅞	24 — 24⅛	24 1/16	23⅞	+ ⅛
50,000	Anglo-Portuguese Tel., 5% Mort. Deb. Stock Red.	100	..	..	..	..	99 —101 xd	101 —103	..	..	+2
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	8 %	6⅞ — 7⅛	6⅞ — 7⅛	..	..	..
1,982,856	Commercial Cable Stlng. 500 year 4 % Deb. Sk. Red.	Stock	4 %	4 %	4 %	4 %	97⅛ — 99⅛	97⅛ — 99⅛	98⅜	97⅞	..
16,000	Cuba Telegraph	10	6¾%	10 %	5 %	5 %	8½ — 9	8½ — 9	..	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 %	17 — 18	17 — 18	..	..	..
12,981	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 %	3⅜ — 3⅝	3⅜ — 3⅝	..	..	..
6,000	Do. do. 10 % Cum. Pref. ..	5	10 %	10 %	10 %	10 %	8¾ — 9¼	8¾ — 9¼	..	..	..
80,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½%	98 —101	98 —101	..	..	..
60,710	Direct United States Cable	20	3½%	3 %	3½%	4½%	15¼ — 16	15¼ — 16	15⅞	15½	..
65,500	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200, R.	100	4½%	4½%	4½%	4½%	100 —102	100 —102	..	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	7 %	144 —147	144 —147	145½	145	..
2,000,000	Do. 8½ % Pref. Stock	100	8½%	8½%	8½%	8½%	90 — 92	90 — 92	92	91	..
1,848,772	Do. 4 % Mort. Deb. Stock Red. ..	Stock	4 %	4 %	4 %	4 %	107 —109	107 —109	109¼	..	..
800,000	Eastern Extension, Australasia, and China Tele.	10	7 %	7 %	7 %	7 %	14⅜ — 14⅝	14⅜ — 14⅝	14 13/16	14½	..
752,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	105½—107½	105½—107½	..	..	..
300,000	East & S. Afric. Tel., 4 % Mt. Db., 1 to 8,000, red. 1909	100	4 %	4 %	4 %	4 %	99 —101	99 —101	99½	..	..
200,000‡	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	4 %	101 —103	101 —103	101½	..	..
180,887	Globe Telegraph and Trust	10	£3	5½%	5⅝%	5½%	10⅞ — 11⅛	10⅞ — 11⅛	11⅛	10⅞	..
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	6 %	14⅜ — 14⅝	14⅜ — 14⅝	14⅜	..	..
150,000	Great Northern Telegraph, of Copenhagen ..	10	12½%	15 %	24 %	24%	37½ — 39½	37½ — 39½	38⅜	..	..
37,900	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	4½%	100 —102	100 —102	..	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	13 %	£8¾ — 60¾	£9¼ — 61¼	..	..	+ ¾
251,127	Marconi's Wireless Telegraph	1	Nil	Nil	Nil	Nil	⅛ — 1/16	⅛ — 1/16	..	..	..
72,680	Monte Video Telephone Co., Ltd. Ord.	1	3 %	3 %	4 %	..	1/16 — 1/16	1/16 — 1/16	..	..	..
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	..	⅛ — 1	⅛ — 1/16	..	..	+ 1/16
1,983,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %	109 —111	109 —111	110⅜	109⅜	..
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	5 %	109 - 111	109 —111	110⅜	109⅜	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %	11 — 13	11 — 13	11 1/16	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %	10½ — 12½	10⅝ — 12½	10⅝	10 1/16	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %	5 1/16— 5 1/16	5 1/16— 5 3/16	5 1/16	5⅛	..
2,000,000	Do. do. 3½ % Deb. Stock Red. ..	Stock	3½%	3½%	3½%	3½%	98 — 100	98 —100	99½	..	..
1,689,598	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	102½—104½	102½—104½	104	..	..
179,313	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6 %	6¼%	7½%	7½%	1 1/16— 1 1/16	1 1/16— 1 1/16	25/3	..	..
50,000	Do. do. do. 6 % Cum. Pref. ..	1	6 %	6 %	6 %	6 %	1 1/16— 1 1/16	1 1/16— 1 1/16	..	..	..
100,000	Do. do. do. 4% Red. Deb. Stock	100	..	..	..	4 %	97 — 99	97 — 99	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
11,889‡	Reuter's	8	5 %	5 %	5 %	5 %	7½ — 7⅝	7½ — 7⅝	7⅝	..	..
60,000	Telephone Co. of Egypt, 4½ % Deb. Red.	100	..	..	..	4½%	101 —104	101 —104	..	..	..
3,201	Submarine Cables Trust	Cert.	6 %	6 %	6 %	6 %	129 —132	129 —132	..	..	..
70,000	United River Plate Telephone	5	7 %	8 %	8 %	8 %	7 — 7½	7 — 7½	..	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5½ — 5¾	5½ — 5¾	..	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	5 %	109 —112	109 —112	..	..	..
15,509‡	West African Telegraph, Shares ..	10	2 %	4 %	4½%	4 %	9⅜ — 10½	8⅞ — 10½	..	..	..
80,008	W. Coast of America, 1 to 80,000 & 58,001 to 58,008	2½	Nil	Nil	Nil	Nil	3/16— 5/16	3/16— 5/16	..	..	..
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	4 %	100¾ — 103¾	100⅝ —103⅝	..	..	..
207,930	Western Telegraph, Ltd., Nos. 1 to 207,930 ..	10	7 %	7 %	7 %	5 %	14¼ — 14⅝	14⅜ — 14⅝	14 5/16	14 1/16	..
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	5 %	.. — ..	.. — ..	..	..	..
563,380	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	103 —106	103 —106	..	..	..
88,331	West India and Panama Telegraph	10	Nil	Nil	Nil	..	⅜ — ½	⅜ — ½	7/6	..	..
84,563	Do. do. 6 % Cum. 1st Pref.	10	7 %*	7 %*	6 %	5 %	6½ — 6⅝	6½ — 6⅝	..	..	..
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	Nil	4½ — 5½	4½ — 5½	..	..	..
80,000‡	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	99 —102	99 —102	..	..	..

Including arrears.

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

170,000	Anglo-Argentine Trams, 200,008 to 430,007	5	..	..	5 %	5 %	7 1/16— 7 3/16	7 1/16— 7 3/16	7⅛	7⅛	..
100,000	Do. Nos. 430,008 to 910,007 and 560,008 to 580,007 ..	5	..	..	..	..	7 — 7¼	7 — 7¼	7⅛	..	..
260,007	Do. 5½ % Cum. Prefs., 1 to 260,007 ..	5	..	5 %	5 %	5½%	5¾ — 6	5¾ — 6	..	..	..
266,500	Do. Permanent, 6 % Deb. Stock, 1888	100	..	6 %	6 %	6 %	138 —141	138 —141	..	..	..
285,100	Auckland E. Trams., 5 % 1st Mort. Deb. Stock ..	100	..	5 %	5 %	5 %	103 —105	103 —105	101½	..	..
800,000	Babcock & Wilcox, 1 to 800,000	1	..	17 %	20 %	20 %	4⅛ — 4⅜	4⅛ — 4⅜	86/3	85/-	..
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	..	6 %	6 %	6 %	1⅜ — 1⅝	1⅜ — 1⅝	..	..	..
38,000	British Aluminium, Ord., 2,001 to 40,000	5	..	..	7 %	7 %	3¾ — 4	3¾ — 4⅛	..	..	+ ⅛
40,000	Do. do. 7 % Cum. Pref...	5	Nil	Nil	7 %	7 %	6⅛ — 6⅜	6⅛ — 6⅜	..	..	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	6 %	6 %	5 — 5⅛	5⅛ — 5⅜	5 1/16	5⅛	+ ⅛
20,000	Do. do. 4 % Funding Certs.	5	..	..	4 %	4 %	4 — 4⅛	4 — 4⅛	..	..	..
300,000‡	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	101 —105	102 —106	..	..	+1
800,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	6 %	117 —120	117 —120	119½	..	..
800,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	5 %	110 —113	110 —113	..	..	..
115,000	Do. 5 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	106 —109	107 —110	108½	..	+1
240,400	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	..	4½%	4½%	4½%	103½—105½	103½—105½	..	..	..
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	..	4½%	4½%	4½%	101 —104	101 —104	..	..	..
133,301	British Electric Traction	10	3 %	6 %	6 %	3 %	5½ — 6	5½ — 6	..	..	..
161,487	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	6 %	9⅝ — 9⅞	9¼ — 9⅝	9 7/16	..	— ⅛
1,415,423‡	Do. do. 5 % Perp. Deb. Stock ..	Stock	5 %	5 %	5 %	5 %	115 —118	115 —118	116½	115½	..
410,178	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	4½%	92½ — 94½	92½ — 95½	..	..	+ ½
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 %	6½ — 7½	6⅞ — 6⅞ xd	..	..	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	5⅝ — 6⅝	5⅝ — 6⅝	..	..	..
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%	102 —105	102 —105	..	..	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	..	4½%	4½%	4½%	97 —100	95 — 97	..	..	—2½
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	1½ — 1⅞	1½ — 1⅞	..	..	..
1,016,358	Do. do. 4 % Mort. Deb. Stock ..	100	..	4 %	4 %	4 %	77 — 83	77 — 83	..	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	15/6 — 17/6	15/6 — 17/6	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731 ..	2	Nil	Nil	Nil	2½%	1 1/16— 1⅛	1 1/16— 1 1/16	..	..	— 1/16
150,000	Do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	6 %	1⅛ — 2	1 1/16— 1⅛	33/9	..	..
125,000‡	Do. 4½ % Perp. Deb. Stock ..	Stock	4½%	4½%	4½%	4½%	93 — 98	93 — 98	..	..	..
125,000‡	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	82 — 84	82 — 84	..	..	..
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	3 %	4 %	3 %	3⅜ — 3⅝	3⅜ — 3⅝	68/9	..	..
40,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	6 %	5½ — 5¾	5½ — 5¾	..	..	..
27,500	Do "B" do. 1 to 27,500	5	..	6 %	6 %	6 %	5 — 5⅛	5 — 5⅛	..	..	..
317,700	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	104 —106	104 —106	..	..	..
190,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	102 —105	102 —106	..	..	..
105,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	8 %	8⅝ — 8⅞	8⅝ — 8⅞	..	..	..
32,610	Do. 105,001 to 137,610	5	..	..	..	8 %	8 — 8½	8 — 8½	..	..	..
350,000	Do. 4½ % 1st Deb. Stock	100	..	4½%	4½%	4½%	103 —106	103 —106	..	..	..
35,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	15%	10¾ — 11¼	10¾ — 11¼	..	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅜ — 5⅝	5⅜ — 5⅝	..	..	..
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	108 —110	108 —110	..	..	..
491,229	Cape E. Trams., 1 to 491,229	1	..	15 %	10 %	5 %‖	⅜ — ½	⅜ — ½	..	..	..
450,000	Castner-Kellner Alkali, 1 to 450,000	1	..	4 %	4 %	6 %	1 3/16— 1 5/16	1 3/16— 1 5/16	..	..	..
280,211	Do. do. 4½ % 1st Mort. Deb. Stock	100	..	4½%	4½%	4½%	97 —102	97 —102	..	..	..
1,939,698	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %	85 — 87 xd	84 — 86	85⅜	85	—1
530,316	Do. do. 4 % Pref. Stock ..	Stock	4 %	4 %	4 %	4 %	97 — 99 xd	97 — 99	98¾	97½	..
530,316	Do. do. Def. do.	Stock	4 %	4 %	4 %	4 %	73 — 76	73 — 76	..	..	..
1,480,000	City and South London Railway	Stock	3½%	2⅞%	2½%	1¾%	43 — 45	43 — 45	44⅛	43⅛	..
85,000	Crompton & Co., Nos. 1 to 85,000	£	5 %	2½%	2½%	2½%	1⅞ — 1⅞	1⅞ — 1⅞	..	..	..
100,000‡	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	95 — 98	95 — 98	..	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ‖ Interim dividends.
§ And bonus of 10s. ¶ From Manchester Share List.

(Continued on next page.)

SHARE LIST OF ELECTRICAL COMPANIES.—(Continued)

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—(continued).

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years. 1902.	1903.	1904.	1905.	Closing Quotations Sept. 11th.	Closing Quotations Sept. 18th.	Business done week ended Sept. 18th, 1906. Highest.	Lowest.	Rise or Fall—
260,000	Dick, Kerr & Co., 1 to 260,000	1	..	..	10 %	..	1⅝ — 1⅞	1⅝ — 1⅞	..	..	..
305,000	Do. do. 6 % Cum. Pref., 1 to 305,000	1	..	6 %	6 %	6 %	1⅛ — 1¼	1⅛ — 1¼	..	..	..
294,150	Do. do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	103 —106	103 —106	..	..	..
60,000	Dublin United Trams. (1896), 1 to 60,000	10	..	5½%	6 %	6 %	14 — 15	14 — 15	..	..	..
59,987	Do. 6% Pref. between 1 and 60,000	10	..	6 %	6 %	6 %	14 — 15	14 — 15	..	..	..
99,261	Edison & Swan Utd., "A" shrs., £8 pd., 1 to 99,261	5	Nil	Nil	2½%	..	1½ — 1⅔	1½ — 1⅔	33/9	30/7½	..
17,139	Do. "A" shares, 01—017,139	5	Nil	Nil	2½%	..	2⅜ — 2⅝	2⅜ — 2⅝	52/6	..	— ¼
344,028‡	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	85 — 87	85 — 87	..	..	..
100,000‡	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	90 — 95	90 — 95	..	..	..
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	Nil	Nil	⅛ — ¼	⅛ — ¼	..	..	..
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	7 %	7 %	7 %	7 %	1⅜ — 2⅛	1⅜ — 2⅛	..	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stk.	Stock	4 %	4 %	4 %	4 %	85 — 88	85 — 88	..	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	5 %	9 — 9½	9 — 9½	..	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	4 %	93 — 97	93 — 97	77/6	..	..
78,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	10	..	3 %	4 %	4 %	3½ — 4	3½ — 4	..	..	..
96,000	Greenwood & Batley 7 % Cum. Pref.	10	..	7 %	7 %	7 %	10½ — 10⅝	10½ — 10⅝	..	..	..
80,000	Do. do. 5 % Mort. Debs.	100	..	5 %	5 %	5 %	101 —102	101 —102	..	..	..
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	15%	12 — 13	12 — 13	12⅜	..	..
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	4½%	5⅜ — 5⅝	5½ — 5⅝	..	..	— ⅛
41,978	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	4½%	107 —109	107½—109½	..	..	+ ½
108,022	Do. do. Scrip. All paid	..	..	..	..	..	107 —109	107½—109½	..	..	+ ½
50,000	India-Rubber, Gutta-Percha & Telegraph Works.	10	10 %	10%	5 %	10%	17 — 18	17 — 18	17 7/16	17½	..
37,500	‡Liverpool Overhead Railway, Ord.	10	14%	12%	12½	Nil	1 5/16 — 1 5/8	1 5/16 — 1 5/8	..	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	5 %	6¼ — 6½	6¼ — 6½	..	..	..
600,070	London United Trams (1901), 1 to 50,007	10	..	8 %	6 %	3 %	8 — 8½	8 — 8½	..	..	..
399,930	Do. do. 60,008 to 100,000 (£6 paid)	10	..	8 %	6 %	3 %	8½ — 4½	3½ — 4½	..	..	..
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	..	5 %	5 %	5 %	8⅞ — 9¼	8⅞ — 9¼	..	..	..
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	94 — 97	93 — 96	94	..	— 1
314,016	Metropolitan Electric Trams, Defd.	1	Nil	Nil	Nil	3 %	⅛ — ¾	⅛ — ¾	..	..	..
500,000	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	1/16 — 1/8	1/16 — 1/8	..	..	..
350,000	Do. 4½ % Deb. Stock Red.	100	..	..	4½%	4½%	98½—100½	98½—100½	..	..	..
20,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 40,000	5	..	..	6 %	6 %	4½ — 5⅛	4½ — 5⅛	..	..	..
24,500	Potteries E. Tro., 20,001 to 40,000 & 50,001 to 54,500	10	..	5 %	5 %	4 %	6½ — 7¼	6½ — 7¼	6 5/16	..	..
24,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	10	..	5 %	5 %	5 %	7¼ — 8¼	7¼ — 8¼	..	..	..
245,000	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	100 —103	100 —103	..	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	15 %	33½ — 35½	33½ — 35½	34½	33½	..
150,000‡	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
8,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	5 %	5 %	90 — 92	90 — 92	90⅞	90⅜	..
540,000	Waterloo & City Railway, Ord. Stock	100	3½%	3½%	3½%	3½%	101 —104	103 —106	102	..	+ 2
66,666	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	5	8½%	8 %	Nil	Nil	⅜ — 1½	⅜ — 1½	..	..	..
66,666	Do. 6 % C. P., 80,001 to 80,000 & 125,001 to 141,666	5	..	6 %	Nil	Nil	2⅜ — 3¼	2⅜ — 3¼	..	..	..
246,806	Do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	77 — 82	77 — 82	..	..	..

ELECTRICITY SUPPLY COMPANIES.

14,000	Bromley (Kent) E.L. & P., 1 to 14,000	5	..	5 %	5½%	4 %‡	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
50,000	Do. do. 4½ % 1st. deb. stock	100	..	4½%	4½%	4½%	101 —104	101 —104	102½	..	..
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	8 %	10 %	10 %	10 %	8¼ — 9	8⅜ — 9	8⅜	..	..
10,623	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	7⅝ — 8	7⅝ — 8	..	..	..
300,000	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	101 —104	101 —104	..	..	..
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	5 %	4⅜ — 5¼	4⅜ — 5	92/6	..	— ¼
80,000	Do. do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	4½%	4⅜ — 5	4⅜ — 5	..	..	..
40,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	4½%	4 — 4½	4 — 4½	..	..	..
40,000	Do. do. 1908	5	..	4½%	4½%	4½%	4 — 4½	4 — 4½	..	..	..
420,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	101 —104	101 —104	..	..	..
44,436	Chelsea Electricity Supply, Ord.	5	4½%	5½%	6 %	6 %	5⅜ — 6	5⅜ — 5⅞ xd	5⅜	5⅜	..
175,000‡	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	106 —108	106 —109	..	..	+ ½
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	6 %	10⅜ — 11½	10 — 11	10⅝	10½	— ½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	12 — 13	11⅞ — 12⅝	12 1/16	..	— ¼
400,000‡	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	123 —126	123 —126	124	..	..
300,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	4½%	101 —104	101 —104	102½	101½	..
40,000	County of Durham Electrical Power, Ord.	2	4 %	4 %	£3 7 0	4 %	2 1/16 — 3 1/16	2 1/16 — 3 1/16	..	..	..
50,000	Do. do. 5 % Pref.	5	5 %	5 %	5 %	5 %	5 — 5⅜	5 — 5⅜	..	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	5 %	8⅝ — 9⅛	8⅝ — 9⅛	..	..	..
80,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	6 %	11⅜ — 12½	11⅜ — 12½	12⅛	..	..
400,000‡	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	107 —110	107 —110	..	..	..
400,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	101 —104	101 —104	..	..	..
80,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	4 %	3⅝ — 3⅞	3⅝ — 3⅞	..	..	..
80,000	Do. do. 6 % Cum. Pref.	..	6 %	6 %	6 %	6 %	4⅝ — 5⅛	4⅝ — 5⅛	5⅛	5	..
320,000	Do. do. 4½ % 1st Mort Deb. Stk	100	4½%	4½%	4½%	4½%	100 —103	100 —103	102	101½	..
10,000	Folkestone, 1 to 10,000	5	..	5½%	5½%	5 %	5⅛ — 5⅝	5⅛ — 5⅝	..	..	..
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	..	..	5 %	5 — 5⅛	5 — 5⅛	..	..	..
75,000	Do. 4½ % 1st. Deb. Stock	100	..	4½%	4½%	4½%	99 —102	99 —102	..	..	..
15,000	Hove, 1 to 15,000	5	..	8½%	8½%	9 %	7⅞ — 8⅝	7⅛ — 8⅝	..	..	..
10,000	Do. New (£6 10s. paid)	£8	..	8½%	8½%	9 %	6½ — 6⅞	6½ — 6⅞	..	..	..
87,303	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	99 —101	99 —101	..	..	..
7,300	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	97 —101	99 —101	..	..	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12½	12 %	10 %	9⅝ — 10⅜	9⅝ — 10⅜	..	..	..
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	98 —101	99 —102	..	..	+1
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	4 %	1⅞ — 2⅛	1⅞ — 2⅛	..	..	..
60,000	Do. do. 6 % Pref.	5	6 %	6 %	6 %	6 %	5 — 5⅛ xd	5 — 5⅛	..	..	..
874,395	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	96 — 99	96 — 99	..	..	..
200,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8½%	10 %	10 %	8¼ — 9	8 — 8½	8⅜	..	— ½
76,121	Do. 4½ % Cum. Pref. 1—71,106, £8 pd.	5	4½%	4½%	4½%	4½%	5¼ — 5½	5¼ — 5½	5¼	..	..
220,000‡	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	109 —113	109 —113	..	..	..
250,000‡	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	3½%	95 — 97	95 — 97	..	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	4½%	98 —101	98 —101	..	..	..
75,000	Newcastle-on-Tyne, 1 to 75,000	5	..	8 %	8 %	8 %	7⅞ — 8	7⅞ — 8	..	..	..
75,000	Do. 5 % Pref., 1 to 75,000	5	..	6½%	5 %	5 %	5⅝ — 6⅛	5⅝ — 6⅛	..	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	7½%	13½ — 14½	13½ — 14½	..	..	..
64,000	Do. do. 4 % 1st Mort. Deb.	100	4 %	4 %	4 %	4 %	97 — 99	97 — 99	..	..	..
18,500	Oxford, 1 to 96 and 407 to 18,810	5	..	6½%	7 %	7 %	6½ — 6⅞	6½ — 6⅞ xd	..	..	..
50,000	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	98 —100	98 —100	..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	12½%	10⅛ — 11⅛	10 — 11	10⅜	10⅛	— ⅛
20,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	7 %	7 — 8	7 — 8	..	..	..
150,000‡	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	3½%	95 — 97	95 — 97	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	4 %	2 — 2⅛	2 — 2⅛	..	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	74 — 78	74 — 78	..	..	..
65,000	South London Electricity Supply, Ord.	5	12½%	8 %	4 %	4 %	3 — 3½	3 — 3½	..	..	..
103,700	South Met. Elec. Lt. & Power (Ord.	1	Nil	Nil	Nil	2½%	1/16 — 1/8	1/16 — 1/8	..	..	..
85,368	*(Late Blackheath and Greenwich* 7 % Pref.	1	Nil	7 %	7 %	7 %	1 1/16 — 1 1/16 xd	1 1/16 — 1 1/16	25/-	..	..
148,292	*Dist. E.L.Co.)* 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	4½%	103 —106	103 —106	..	..	..
50,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	5 %	3½ — 4	3½ — 4	..	..	..
80,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	4½ — 5	4½ — 5	97/6	96/9	..
90,000	Do. do. 4½ % 1st Mort. Deb. Stk. Red	100	..	..	4½%	4½%	99 —102	99 —102	..	..	..
110,000	Westminster Electric Supply, Ord.	5	12 %	13½%	14 %	13 %	9⅞ — 10⅜	9⅞ — 10⅜	10	9⅞	..
23,151	Do do. 4½ % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅛ — 5⅜	5⅛ — 5⅜	5 5/16	5⅜	..
	(Originally 5 %—Red. to 4½ % from 31st Dec., 1905.										

Shares not officially quoted:—Mackay Companies, ord., 75—77. Pref. 74—76.

† Unless otherwise stated all shares are fully paid. ‡ Interim dividends.

(Bank rate of discount 4 per cent. September 13th, 1906).

REVIEWS.

Electric Machine Design. By H. F. Parshall, M.Inst.C.E., and H. M. Hobart, M.I.E.E. London: *Engineering.* Price £2 2s. net.

This is a revised and enlarged edition of the authors' work on "Electric Generators," published about four years ago. To the original section on Continuous Current Generators many additions have been made, including designs of machines that have proved in practice to be particularly good.

The authors remark in the preface that in "Electric Generators" certain designs not of the greatest excellence were included as illustrative of certain features; in the present edition they have made it, as far as possible, a principle to include only machines which have proved in practice to represent an advanced state of the art of electric machine design.

The designs given in the book are to illustrate different phases of dynamo construction, and not to furnish working models for manufacture, as no well-advised engineer would blindly follow another's designs.

Part I deals with Continuous Current Generators, and commences with a discussion of the different materials used in construction and their chemical composition, magnetic and electrical qualities.

Among the apparatus for hysteresis testing, there is given a description of the arrangement used by Messrs. Siemens and Halske, in which entire sheets are tested instead of little pieces cut from them, a method which permits of much more reliable results being obtained. A large number of magnetisation curves are given for different classes of iron and steel. In several cases the curve of residual magnetism is also given, this information being of considerable value in some classes of designing.

Hysteresis curves are given showing the effects of annealing, ageing and pressure.

Insulating materials are very fully treated, insulation curves of a number of different materials being given. The authors tell us that rubber should never be used in any form in dynamo machinery, a remark which recalls painful experiences of 15 to 20 years ago.

In the chapter on E.M.F., the variation of E.M.F. with variation of the arrangement of conductors on alternator armatures is dealt with. This is a useful chapter for reference, showing as it does the most favourable arrangements. Perhaps in a future edition the authors could supplement this by showing the modifications produced by the fringe around the gap.

A number of experimental heat tests are given, showing the temperature at different points between the inner and outer layers, the rate of rise on time runs, &c., of field spools. Considering the enormous amount of information which the authors give us, it may seem greedy to ask for more, but if they could furnish similar information relating to armatures it would be very acceptable.

A point on which there is always some uncertainty in calculating the temperature rise of armatures is the question of the core losses. Our information on this subject is considerably augmented by the curves which the authors give, based as they are upon actual tests of a large number of machines.

In the chapter relating to the design of magnetic circuit a number of leakage factor diagrams are given, and calculations for the magnetic circuits of induction motors.

One of the most important portions of the book is that relating to the commutation of continuous-current machines.

The general method adopted by the authors to ensure sparkless collection is twofold, first, to restrict the cross ampere-turns on the armature to a certain limit relatively to the forward excitation; and secondly, to keep the reactance voltage at each set of brushes within a given amount which appears to vary with the size of the machine.

The limiting value which the authors give to the cross magnetising ampere-turns appears to be equal to the forward ampere-turns of the air-gap and teeth.

Thus, in a 1,500-KW. machine, of which full details are given, the cross ampere-turns amount to 9,490, while the forward excitation (gap + teeth) is 9,000. In a 550-KW. machine the figures are 7,400 and 7,100 respectively. In the remaining examples given, both of generators and traction motors, the cross ampere-turns are less, generally considerably less than the forward excitation. For generators the reactance voltage appears to be kept in the neighbourhood of 4, except in the case of the 1,500-KW. machine in which it is 8. This machine is stated to work quite sparklessly, even with considerable overloads (when, of course, the reactance voltage would be still higher), and it would be interesting to know the special points in the design which enable this satisfactory result to be obtained with such a high reactance voltage.

In the examples given of traction motors, two machines of 24 and 27 H.P. have reactance voltages of 11 and 9·9 respectively, while a later machine of 117 H.P. has a reactance voltage of 5·3.

Rotary converters are dealt with in Part III, conversion from alternating to continuous only being treated, as the authors point out that difficulties are liable to arise if the machines are used for the opposite purpose.

Armature winding diagrams and tables are given; also complete detailed particulars of two rotary converters of the authors' design. This section concludes with a discussion of the relative advantages of rotary converters and motor-generators, in which the limits to the use of the former machines are stated.

The design of alternators is treated in Part IV. The information in this, as in the previous sections, is remarkably full, and examples are given of various alternator designs.

Now that turbine generating sets are coming into such extended use, any information relating to the design of this class of machinery is exceptionally welcome, and we are glad to see that the authors have taken up this subject in the two concluding sections of their book.

Turbine sets, both for alternating and continuous current work, are treated, and in connection with the latter the use of commutating poles, to ensure sparkless collection at the high speeds at which turbines are run, is fully dealt with. Various useful tables are given in an Appendix.

C. W. H.

Modern Polyphase Machinery. By A. Stewart. London: S. Rentell & Co. 1906. Price 5s. net.

This book, like most of the books which have recently been written on polyphase machinery, is for the use of the practical engineer. It originally appeared as a serial in the pages of *Electricity*, and has now been revised and brought up-to-date. Some of the descriptions of the methods of constructing machines are good, but taken as a whole, we cannot recommend the book.

The printing of the few mathematical equations and formulæ is very badly done, and some of the diagrams are drawn carelessly. For instance, Ca × Ra (p. 39), does not stand for CRa^2, but means the product of the armature current by the armature resistance. It is highly probable that the printer is more to blame than the author in several places, but the general effect is unfortunate. In our opinion a little more care spent on the general get-up of technical books would well repay both authors and publishers.

The chapter on insulators and their properties does not meet with our approval. It is stated that the dielectric strength of a material diminishes as its thickness is increased. It is only recently that electricians have begun to see what an absurd statement this is. In our opinion, what Principal Carey Foster calls the "electric strength" of insulating materials depends mainly on their temperature and hygroscopic condition, and is practically constant. The experiments quoted extensively at Institution debates and elsewhere to prove the contrary, merely show that the experimenters were unaware of the meaning of electric intensity, and how it is measured.

The theoretical parts of the work could easily be improved. For instance, the following extract is meant to assist the practical man in understanding the phenomenon of resonance. "The network itself may be considered as having a certain periodic time, *i.e.*, if a wave of E.M.F. is impressed upon it, it will surge through the network and re-appear at the terminals.

"If that wave of E.M.F. took 1·2 seconds to traverse the

network it would then synchronise with the fundamental E.M.F. of a 50-cycle alternator, and we should have complete resonance as the periodic time of the network would be the same as that of the alternator" (p. 98).

The first sentence is almost unintelligible. We suppose that 1·2 is a misprint for 0·02. We are sure that the author with a little care could have expressed himself better. From the second sentence we get the impression that the phenomenon is due to synchronism between a free and a forced oscillation. This is undoubtedly correct, but it would have been helpful to beginners to give mechanical analogies.

On p. 103 we are told that the electrician is indebted to Prof. Joubert for first simplifying the theory by introducing the sine function. This is not the case, for Clerk Maxwell uses it in the *Phil. Trans.* for 1865 when explaining the theory of the transformer. He, however, would not have claimed any particular credit for introducing it, as it was used for 100 years previously in explaining the exactly analogous phenomena in optics.

In talking of the leakage in induction motors (p. 206), it is stated that a certain magnetic dispersion is frequently termed flank dispersion, and was so described by Dr. Hans "Eschenberg." As a matter of fact, Dr. Eschenburg called it *stirnstreuung*, and his translator gave it the absurd name of flank dispersion.

The reader will gather that the reviewer is prepared to criticise this book at considerable length. The reviewer, however, is of opinion that the author has not done himself justice, and that if he cut out the parts of the book about which he himself must feel doubtful, its value would be considerably increased. In engineering theory little attention should be paid to authorities. The "Fathers" of the engineering profession have generally considered consistency as the meanest of the virtues. If they had worshipped it more consistently our industrial progress would probably have been slower.

Management of Accumulators. By Sir D. Salomons. Ninth edition, revised. London: Whittaker & Co. 1906. Price 6s. net.

That a widespread demand exists for a practical book on accumulator management is evident from the fact that not only has Sir David Salomons's book reached a ninth edition, but it has also been translated into French, German, Spanish and other languages.

In the preface the author tells us that descriptions of obsolete types of cells have been omitted, and that only those types which are in common practical use are dealt with. It is probably for this reason that no mention is made of the Edison accumulator.

Whilst there is a good deal of practical information in the book, there are some expressions which, perhaps owing to the loose wording—a marked characteristic of the volume—are somewhat confusing.

On page 37 the author tells us the cells now so largely used are the Faure cells improved. As a matter of fact, most makers of repute now use Planté plates for their positives. In fact, on the pages immediately following, the author points out that the Planté type is largely superseding the pasted type.

The repetitions in the book seem to indicate that the proofs have not been very carefully revised. Thus, on page 40, we read:—"The two sets of plates are pushed into one another so that the positive and negative alternate .... every plate being insulated from the next one by some non-conductor called a separator;" and again, on p. 43, we read:—"The two sets of plates are pushed into one another, so that the positive and negative alternate, every plate being insulated from the adjoining one by the insertion of separators." This is just one example out of a number that might be cited.

Then, as to the looseness of wording, the following is a typical case:—"The section is now ready for forming—that is to say, to receive a charging current for a long period, so that the plates may be chemically charged to retain a charge; or, in other words, have capacity."

The description of the Chloride plate is, we think, not quite up-to-date in detail, as we understand that the lead rosettes are not now riveted over under a pressure of 8,000 lb. per sq. in., nor do the negative plate pastilles consist of chloride of lead with a small percentage of zinc. Nor does the term "Exide" refer to the construction of the positive plate as stated by the author.

In the chapter on Failures, Causes and Remedies, some very good practical information is given, and this is the chapter which will perhaps be most useful to those in charge of installations.

A very interesting point is mentioned on page 144, namely, that when plates are charged at too slow a rate, about 10 per cent. of the maximum permissible rate there is a tendency for the paste to throw out short crystal needles which have the effect of reducing the capacity of the cell. It is possibly the prevention of this partial short-circuiting which accounts for the slightly better results claimed by the Chloride Co. for cells fitted with wood pulp separators instead of the usual glass tubes.

A CHAT ABOUT STEAM TURBINES.

By E. AUSTIN.

(*Concluded from page* 434.)

It is well known that the dummy pistons are grooved, and that strips of brass are let into the turbine casing, into which the grooves in the dummy pistons fit; were these not provided, steam would simply leak from one expansion to the other, and the steam consumption would be very great. It is desirable in order to obtain low steam consumption to have the grooves in the dummies running as near the sides of these brass strips as possible, but it is extremely undesirable that they should touch. Should they do this, the results are often rather more serious than at first sight would appear probable. The brass strips, as a rule, are very effectively torn from the turbine casing, but the trouble sometimes does not end here, for the rotor spindle may also be bent, causing the blades to strike the cylinder, and resulting in a strip in one or more of the expansions.

When a new turbine is sent from the makers, the dummy pistons are set off these strips by a known amount depending on the size of the turbine. It is termed lining-off, and is expressed in thousandths of an inch. It varies from about ·005 in. in the small sets to ·015 in. in the larger, hence if a turbine is said to be lined off ·01 in., for instance, it means that the distance between the brass strips let into the cylinder, and the nearest sides of the grooves, is ·01 in.

The method of lining off will be readily understood by lifting the steam end keep. Behind the thrust bearing will be found a small brass liner. When this is removed it will be found that the rotor has a certain amount of end play, and by means of a pinch bar it will be possible to shift the rotor both backwards and forwards. The rotor may be moved by placing one end of the bar in one of the rings on the thrust, and the holding down studs for the steam end keep will be found to answer for a fulcrum for the lever. In the large sizes, above 1,000 KW., the rotor is generally too heavy to shift in this manner, and it may be found necessary to lift the cylinder cover and shift the rotor by means of a small jack placed between the dummy pistons and the turbine casing. Before doing this, however, an endeavour should be made to shift the rotor by means of two bars, operated by two men, one on each side of the turbine, but care should be exercised not to bend the thrust rings. To line off, the rotor is pulled towards the steam end as far as it is possible for it to come, and when no further movement in this direction can be obtained, it may be concluded that the grooves on the dummy or balance pistons are in contact with the brass strips. The thrust bearing is then gently pushed forward in the direction of the exhaust end to make sure that it is in contact with the thrust on the rotor shaft. The space at the back of the thrust bearing is next *carefully* measured by means of a feeler gauge. For the sake of illustration, we will suppose this to be ·02 in., then if the dummy pistons are to be lined off the strips ·005, the thickness of the brass liner to be placed behind the thrust bearing will obviously be ·025 in. The lining off is, of course, done at the manufacturer's works.

and it might appear unnecessary to trouble about it once the job has been done, but with a little consideration, it will be seen that after considerable running, wear is likely to take place at the thrust and its bearing, resulting in the sides of the grooves in the dummy pistons coming in contact with the brass strips. The amount of wear at the thrust bearing is dependent on the end pressure, and although particular care is exercised to reduce this to a minimum by altering the gauging of the blades before the turbine leaves the works, yet it cannot be reduced to such a small value as to guarantee absolutely no wear whatever, and as ·005 in., for instance, is not what might be termed a large amount of wear, it follows that it is expedient, in order to guard against breakdown, to test this occasionally.

The makers are always pleased to supply information with regard to the correct amount of lining off, and, in fact, invariably give it on the instruction sheet. With this information, the checking over may be described in detail as follows :—Immediately the turbine has been taken off load and is perfectly hot, the steam end keep should be lifted, the brass liner from behind the thrust bearing should be removed, and the rotor pulled in the direction of the steam end in the manner described, and very great care should be exercised to ascertain that the grooves in the dummy pistons are in contact with the brass strips. It is best, if possible, to bring the rotor forward with one jerk, when the pistons will be heard to hit the strips. The thrust bearing should then be pushed towards the exhaust and the distance behind the thrust bearing carefully measured by means of a feeler gauge. When this has been done, the rotor should be levered forward a little while the liner is replaced behind the thrust bearing, but the liner should only be put in halfway; that is to say, half of the liner should be left projecting above the surface of the casting and thrust bearing, so as to leave a gap behind one side of the thrust bearing for taking another measurement by means of the feeler gauge. With the liner halfway in position, the rotor should be again levered towards the steam end, and will this time push the thrust bearing behind it, thus clamping the liner tightly. Another measurement should now be taken behind the thrust bearing, and the difference between this measurement and the first will obviously be the amount by which the dummy pistons are off the brass strips. If this is found to be less than the amount given by the makers, a new liner should be made which should be carefully gauged by means of a micrometer gauge, and should, of course, measure more than the old liner by the amount deficient. When the new liner has been made it should be placed in position and the lining off checked over, as described above, and having made sure that it is correct, the liner should be pushed down into position so that its ends are flush with the thrust bearing. The steam end keep should then be replaced, and having levered it back away from the exhaust end as far as it will go, it may be tightened down by means of the nuts. The stop in front of the steam end keep should then be set back about ·003 from the front of the turbine casing, when the machine is ready for running again.

At this point we have now cleared away the principal queries which arise in connection with the running and upkeep of turbines, and it cannot be denied that engineers are relieved of an enormous amount of work when this type of plant is installed, as compared with reciprocating engines. Nevertheless, it is only natural that engineers like occasionally to examine the interior of their turbines, say once in two years. Moreover, it is advisable that they should do so, for accidents with machinery are always possible, no matter how well it is constructed and how carefully it is used. Blades have been known to be stripped from one or more of the expansions without anyone knowing anything about it until the cylinder cover has been lifted, and the only thing that has led to suspicion is the high steam consumption of this particular set. While speaking of blade stripping, it will, perhaps, be as well to mention the general causes other than that already mentioned. Abnormal superheat is, no doubt, in some cases responsible, and as pointed out by Mr. W. H. Booth some time back in an article in the Electrical Review, our present superheaters are open to improvement in this direction; but until such improvements arrive it appears to the writer that an automatic alarm might easily be invented to give warning when the correct figure was exceeded. Very heavy priming may also cause blade stripping, but for damage to result from this cause, only very great carelessness or very defective design of the boilers and pipework can be blamed. Carelessness in closing up the turbine when erecting or after opening out for repairs is not to be overlooked, or allowing minute pieces of metal or other matter to be present in the turbine itself, or the steampipe in front of the strainer will in all probability cause trouble sooner or later. When the turbine is first erected, the strainer should be thoroughly examined, and under no circumstances whatever should it be used if in any way damaged, so as to allow small particles of steel from the new steam pipes, for instance, to get amongst the blades. There are other causes of blade strips, but they are even more obvious than those already described, hence it is unnecessary to deal with this matter further.

If, on lifting the cylinder cover, the blades are found to be in perfect order, and there are no signs of the bearings having been warm at any time, and the dummy pistons have every appearance of being clear, that is to say, if they are properly lined off the brass strips, then there is little call for further work. If, on the other hand, the bearings appear to require attention, or if there is reason to believe that they have been subjected to any appreciable wear, the rotor should be removed. The wear on the bearings, provided that a good pressure of clean oil has always been maintained, is exceedingly small, as it is only that due to the steady weight of the rotor, and not to any working forces, as in the case of reciprocating engines. Turbines have been known to run continuously for years with practically no repairs except perhaps new seatings for the double-beat controlling valve. Should, however, it be necessary to attend to the bearings, great care should be exercised in lifting the rotor. A set of slings should be kept expressly for this job, and it would be well that the station fitter should take a lesson from the contractors' men on lifting and lowering the rotor before the work is attempted, for a sudden swing of the rotor may be sufficient to bend the blades, which can only be put back in position by means of special tools and skilled hands. If, however, it is lifted perfectly level, and very slowly, and if there are plenty of intelligent hands to guide the rotor blades clear of the fixed ones, there should be no fear of damage.

The difficulty is obviously far greater with large machines than with small ones, owing to the additional length and weight of the rotor. If it is necessary to make any alteration to the old bearings or to use new ones, on no account should the turbine be closed up until the clearances have been taken. The original clearances can, no doubt, be obtained from the builders, as these are, of course, taken before the machine leaves the works, and although it would be probably a very difficult task to make them exactly the same when new bearings have been fitted, it is desirable that the new clearances should correspond with the old ones within a thousandth or so.

There are, in all, four clearances to be taken for each expansion, namely, the top and bottom, and the two sides. The side clearances are generally taken first, by means of a feeler gauge, which should be inserted both between the fixed blades and the rotor shaft, and between the rotor blades and the turbine casing. This is, of course, done while the rotor is lying in its bearings with the cylinder cover removed. Each ring of blades should be tested in each expansion. When both sides have been taken, and if the spindle is found to be lying central, that is to say, if the clearances are found to resemble the original ones, the top and bottom clearances may next be taken. This is done by means of lead wire placed between the moving blades and the turbine casing, and between the fixed blades and the rotor spindle. A number of pieces of lead wire are cut off about 2 in. long; these are flattened out and measured by means of a micrometer gauge, and their thickness is made a little more than the original clearance. Suppose, for instance, it was found from reference that the original clearance over the moving blades in the first expansion was ·02, then the thickness of the wire to be used for testing this clearance should be about ·025 in. As the expansions approach the exhaust end the clearances increase, and it will, therefore, be necessary to use thicker

leads in the last few expansions. Two pieces of wire will be used for each expansion—or rather, four pieces in all, two for the bottom clearances and two for the top. Having cut off these short lengths of wire, and having flattened them out as described, the rotor may be lifted, and the leads placed in position; one will, of course, be simply placed at the bottom of the cylinder casing, while the other will be fixed to the edge of the blades at the bottom of the cylinder, the fixing being effected by bending the wire up at right angles for about $\frac{1}{8}$ in. at each end, so that the ends fit between the blades. When all the expansions have been treated in this manner, the rotor may again be lowered into position, and when this has been done it should be *slightly* turned first one way and then the other, so as to make an impression on the lead wires about $\frac{1}{4}$ in. long, the rotor being turned by means of a bar placed under one of the bolt heads on the flexible coupling. The leads for taking the top clearances should next be placed in position. One lead will be placed on the surface of the rotor spindle and the other fixed to the top of the rotor blades by turning the ends at right angles, as described, and when this has been done in all the expansions, the cylinder cover should be replaced, thus pressing the blades into the leads. Several bolts should be put in and pulled down tightly; the rotor should then be turned by means of the flexible coupling as before, in order to make an impression in the top leads, about $\frac{1}{4}$ in. long, as in the case of the bottom ones. The cylinder cover may then again be lifted, when the thickness of the leads should be measured by means of a micrometer gauge, and the measurements for each expansion should be carefully recorded in a book. The spindle is then lifted, and the bottom leads measured and recorded in exactly the same manner. It is very improbable that a man who is new to this work will get satisfactory leads the first time, perhaps owing to the leads being too thin to start with, and it is generally necessary for inexperienced hands to do the work over at least twice before perfection is attained.

Generally speaking, the clearance between any of the blades and the casing or spindle should not be less than ·02 in., but, as already stated, reference should be made to the original clearances, which no doubt the makers will be willing to supply.

Balancing the rotating parts of a turbine does not fall to the lot of those who are responsible for their upkeep, for once a good balance is obtained at the maker's works, there is very little fear of trouble in this direction. In the case of continuous-current generators, however, the balance sometimes gets a little imperfect by reason of excessive wear on the commutator, and if the station engineer is inclined to endeavour to rectify this, he can do so by adding or taking weight from the balance rings. The light places can generally be found by running the machine up to speed and holding a blue pencil lightly against the shaft. This should be done at about three different speeds, when the breaks in the lines made on the shaft will generally indicate where weight is to be added. If the makers' weights are removed, great care should be taken to mark where each respective weight has been taken from, for balancing often proves a very ticklish job; and it is well not to lose sight of the places where weights have been added, for there is no telling how long it has taken the makers to find these places, and the correct weight to place on them. Moreover, it might be found quite impossible to run the machine up to speed with the balance-weights slightly displaced.

In conclusion, the main points in connection with the running and the up-keep of steam turbines have been dealt with. The writer is aware that several minor details have been omitted—such as the oil cooler, &c.—but such things are used in connection with reciprocating engines and in other branches of engineering work, hence it is unnecessary to deal with them here. From the foregoing, it will be fully realised that the work involved in the up-keep of a steam turbine is far below that of a steam engine, and what time the fitters have on their hands in a turbine station may be spent with advantage on the condensers. High vacuum is the watchword in a turbine station, and fairly frequent overhauling of the air pumps, and an occasional coat of red lead on the exhaust pipe joints, all help to efficient running.

COST OF SUCTION GAS POWER.

[COMMUNICATED.]

"Twenty B.H.P. at a penny an hour!" There is a very wise little couplet that runs :—

> One man's word is no man's word,
> Justice needs that both be heard.

This applies very strongly to statements which, made before certain agricultural and other organisations, and reproduced in the daily and other papers, have fascinated owners of works, prepossessing them in favour of suction gas plants. One of the principal of these assertions is that 20 B.H.P. can be produced by such plants at the cost of 1d. per hour for fuel. It possesses the merits of epigrammatic simplicity and bold assertiveness, and therefore it has stuck. Like most bold assertions, however, it is only partially true.

The other Side of the Shield.—It is time that the other side of the shield should be displayed to possible power-users in the same way and through the same means as have been used to disseminate the partial statements above alluded to. Failing the immediate use of such means, inasmuch as the defects of the system are displayed by day-by-day wear and tear, and not by means of showy "tests," a fair summary of the case appears necessary.

In addition to the running charges, the following items must be taken into consideration in determining the actual cost of generation :—Capital charges, labour, cost of water, charges on account of renewals and depreciation, provision against obsolescence, and insurance against employers' liability.

The problem, however, is not even so simple a one as equating costs of generation and maintenance of two or more equally good systems of supply. It is only right to say that in the case of suction gas producers certain defects have occurred which are either inherent or the cures for which have not yet been discovered. Such drawbacks are the necessity of skilled operators to work the producers (we make and will prove this statement, in spite of the assertion of suction gas plant manufacturers that an unskilled man can successfully work them); together with the variation of the quality of the gas with the condition of the charge and the work on the engine, involving the obtaining of good (and high-priced) coal, and the adding of many little accessories to facilitate operations which destroy the original simplicity of the plant.

We will deal with this two-fold problem a little more in detail.

Initial Cost.—The subject of initial cost is being very unfairly discussed by certain suction plant manufacturers. They emphasise the beautiful simplicity of a self-contained, simply-progressive mode of power production, but omit to state that if any part of the process breaks down the whole plant is thrown out of action. There is no provision for storage; gas is generated as a result of the motion of the engine. Hence the capital cost to avoid serious loss from breakdown is not merely the cost of a single plant, but an additional charge is introduced for stand-by duplicates. Ask a manufacturer of this kind of plant for a list of spare parts necessary to avoid a long shut-down, and one's ideas as to the simplicity of suction gas production are apt to be modified. The alternative to duplicate plant is to have town gas as a stand-by. The gas manager will not be found in an enthusiastic frame of mind when a spasmodic demand occasioned by the breakdown of private gas plants is suggested to him.

Labour.—The question of labour involved in running such a plant is subjected to very subdued treatment by advocates of suction gas. This point arose some little time ago in a discussion at the Junior Institution of Engineers, and the most powerful assertion advanced against the citation of accidents due to unskilled use of these plants was that "we can make these things fool-proof, but not idiot-proof." This not only advances a rather pessimistic estimate of the labouring man's intelligence, but admits difficulties of operation which have not yet been coped with. The practical remedy is the employment of skilled men with a due sense of responsibility and an apprehension of their danger, having a thorough working knowledge of the details of the plant for which they are responsible. It is no fool's job to run a suction gas plant so as to get such work as is

possible out of it, to take care of employers' interests, and to look after one's own life. The "unskilled operator" for a suction gas plant is a myth.

Cost of Water.—It is not every manufacturer who is so situated as to be able to draw his water from the running brook in order to get steam to pass through his bed of incandescent anthracite. Now the average amount of water taken by a suction gas plant is 3 gals. per B.H.P. per hour. Allowing as a fair average price 1s. 2d. per 1,000 gals. (though this may be considered as a moderate rate for small manufacturers), the price of water alone for 20 B.H.P. is ·84d. per hour. This one item goes a long way towards doubling the vaunted "penny."

Renewals and Depreciation.—There are certain parts of suction gas plants that call for frequent renewals and repairs. For example, fire-brick linings depend very largely for their life on sympathetic treatment by the "unskilled labourer" in clinkering his fires. With luck, the linings may last a year or eighteen months, but the shape of the fire and the difficulty of drawing clinker put a premium on exasperation, and the downward punches of the clinkering bar as wielded by a hot and determined navvy will lead to the speedy displacement of the brickwork. The vaporisers are liable to get out of order fairly quickly, due to the presence of steam and rapid temperature changes, and the heat variation difficulty also applies to the coal hoppers and other parts of the producer. All this requires strong and massive construction (not always provided for in the initial cost of the "$\frac{1}{20}$d. per B.H.P.-hour" plants), and also intermittent repairs by skilled workmen—who, by the by, are not always on the job, and who, therefore, extend the period of breakdown by the time required to get them to the spot. The remarks of the *Journal of Gas Lighting* on this subject will bear repetition :—"It is not likely that all the component parts of the plant will, out of consideration and respect for their owner, fall due for repair simultaneously, so that the plant will thereafter run without stoppage for repair again for (say) another period of 12 or 18 months. There is something yet to be learned on this question of renewal and depreciation."

Obsolescence.—Suction gas plant manufacturers are still extremely busy groping around for perfection. Unfortunately the problem is somewhat complex, as apparatus designed to meet one difficulty very often accentuates another. As each variation is tried and placed on the market, there is a flourish of trumpets, the only real purport of which is that the design of suction gas plants is in a most unsettled condition. Plants change quickly in important parts of their design. The difficulty of getting spares and renewal parts is made greater, and every plant at present in use runs great risk of being shortly superseded by a different type. In short, if it is not obsolete it is obsolescent. A manufacturer investing his money in a plant to-day may to-morrow be in competition with a neighbour who has bought a newer type of superior economy. Till the suction gas plant industry is in a more settled condition, it is worth a manufacturer's while to refrain from entrusting the drive of his factory to this mode of power production.

Employers' Liability.—Under the present administration of the Employers' Liability Act it is a fact that, within very wide limits, an injury to an employé engaged upon civil, mechanical or textile works while in the pursuit of his employment, is sufficient ground for compensation. This being so, it behoves the manufacturer to be extremely careful as to the number of chances he gives to his "unskilled operator" to do himself harm.

One of the champions of suction gas plants, Mr. W. A. Tookey, has written a book entitled "Gas Producers for Power Purposes," in which, of course, as good a case is made for this form of power as is conveniently possible. It is, therefore, instructive to note the following statements therein :—

"Producer gas emits a very distinctive odour, and its presence therefore can usually be detected. It is dangerous to life, as the carbon monoxide in it causes asphyxiation. All vent pipes must therefore be led away to the atmosphere to such a height that this danger is removed. . . . Suction producers are much safer in this respect (than pressure producers) as, after they have once been put in connection with the engine, the pressure throughout the plant is less than that of the atmosphere. . . . At starting and at shutting down times, however, care must be taken. The test cocks at the different parts of the apparatus should not be left on if it is found that the gas emanating is not sufficiently rich to burn. . . . For similar reasons the generator hopper-cover should be shut as soon as the fire is alight and the fuel has been placed on the fire. The gas house and engine room should be well ventilated and a current of air allowed to pass through. . . . In the event of the gas "almost burning" upon the application of a match or taper, it is very tempting for the attendant to keep the test cock open until the gas coming through will burn. In the hands of careful men no danger may be feared, but a point should always be made in instructing a new attendant of the poisonous nature of the gas. . . . . As the producer gets into work the smell is not so noticeable, as carbon monoxide, a gas which has little or no smell, is then of greater proportion."

It must be remembered that the carbon monoxide is the asphyxiant. As, therefore, the proportion of poison becomes greater, the warning becomes less. Again :—

"The calorific or heating value of producer gas is much less than illuminating gas. . . . The amount of air required to mix with producer gas for complete combustion is much less than that mixed with illuminating gas, and, therefore, explosive mixtures are more readily obtained."

On two accounts, therefore—asphyxiation and explosion—suction gas presents factors promoting calamity in addition to the usual causes of accident met with in engineering works.

Necessity of Skilled Operation.—In the above-mentioned book a chapter of 17 pages appears with the title "Hints to Attendants." The limits of the chapter are stated as follows :—"These notes . . . . do not state remedies for every ailment, but suggest the best method of working the producers to obtain uniform and constant gas, with special application to suction gas producers."

First comes the fire building, lighting and blowing. The attendant is warned to see, after his efforts, that the fire has not died out, "as sometimes after many minutes' blowing up it has been found that the fire was dead." The remarks of the "unskilled operative" would probably be unstudied. There follow notes as to comparative advantages of low and high levels for fuel in the generator, amount of water to be placed in the vaporiser (which appears a somewhat complex problem), manipulation of the fire to meet sudden demands, fuel storage in the hopper, barring down the fuel, selection of the fuel, clinkering—"sane designs are more favourable than others in this respect, but usually, for more than 12 hours' continuous work, two generators should be provided, so that one can be cleaned out while the other is in use"—regulation of velocity of air and steam. One has to watch the regulation of water admission—"with a too generous supply of steam the fire will become dull, and will not maintain the heat that is required for the decomposition of air and steam, the result being that gas of little heat value will be supplied to the engine, which will, therefore, stop if not remedied in time"; whereas, "too little steam and consequent poorness of gas will cause the engine under loads approaching the maximum to take in frequent charges, causing the fire to 'draw up' to an excessive degree, and thus to overheat the generator, damaging probably the fire-brick lining and the iron casing."

Coming to the gas engine, "it will be found necessary to arrange the time of firing when the engine is under full speed at a point much earlier than is wanted at starting." Generally speaking, the perils that beset the man who starts the engine appear to be conducive to bad language. He has to try the gas at the trial cock, noting the colour of the flame, clear the bottom of the fire in the generator, set the fly-wheels in motion, give the spark by hand ("should the gas be very rich or very poor, different adjustments will be required to the gas and air valves, and only experience will help the attendant in this matter"). Other pitfalls are: the dragging over of the gas too quickly from the generator, on which the engine stops incontinently; making the depth of the fire too much for the starting load of the engine—for this, a plank put under the fly-wheel to act as a brake when speed is attained is recommended; rich gas accumulating in the scrubber and pipes, the excess of poor gas causing the deluded engine to stop.

On shutting down, the water seals, vent pipes, water and air supply must be attended to. "The great point to observe, when shutting down, is to prevent the air getting to the generator; if this should happen, an explosion would follow from the heat of the fire." The dangers of cleaning are summarised as follows: "The cleaning process should not be attempted by one man alone. It is advisable for two men to be detailed for the work, in case the gas should overcome one of them. The man must be made aware of the risk of asphyxiation as well as the risk of explosion."

It would therefore appear from the writings of Mr. Tookey, that the phrenological development of the "unskilled operative," placed on a job of this sort, is likely to be phenomenal.

Sweet Simplicity.—The chief claim of the suction gas plant is to simplicity. The foregoing paragraphs enumerate a few of the points about the apparatus which indicate that at present the manufacturers of this plant need not sigh for more worlds to conquer.

Even the original simplicity of the producer has been varied of late. A few of the complicated "improvements" which have been introduced to give a closer approximation to steadiness of performance may now be mentioned:—

Automatic devices to cut off steam entirely at light loads; by-passes round the gas valve to cause an artificial draught through the fire at light loads; special arrangements on the hoppers to prevent entry of air; devices for warming the air before it reaches the fire; superheaters for steam and air mixtures on their way to the fire; automatic water inlets; electric motors to run the "blowing-up" fans, and what not. And with all this complicated refinement we are astonished to find that it is so difficult to start a suction gas plant that the town gas supply is often used to get up the necessary speed, and, after the suction plant has been respectfully treated and got into a nice working condition, the engine is switched over from the town supply to the private plant. Simplicity itself!

Conclusion.—A Scotch minister once found his elder on the Sabbath with a gun over his arm and a very fine hare in his hand. "Tammas!" he said, "d'ye ken it's the Sawbath?" "Aye, fine that! D'ye ken whit a wark o' necessity is?" "Ou, aye! Hoo wis shootin' that hare a wark o' necessity, Tammas?" "Aweel, if I'd waitet till the morn the hare wud hae been awa!"

The suction gas people are busily pushing around getting all their orders to-day. To-morrow, a little more about suction plants will be known, and the "hares will be awa!"

THE MAXIMUM DEVELOPMENT OF THE STEAM ENGINE.

From time to time we have been told that the maximum has been reached as regards the steam pressures at which an engine can work, but each statement of the limit has usually been followed by an extension beyond it. Better workmanship has been one of the reasons that have enabled engines to employ steam of higher and higher pressures.

Improvements in materials have had their weight also in enabling the steam engine to use higher pressures, but the limit has usually been set by the boiler. Indeed, it may almost be said that it is the boiler that has really set the limit. Thus the introduction of steel of greatly increased strength as compared with iron was productive of a great advance in pressure. The Adamson flanged seam enabled flues to withstand the crushing effect of the pressures that the shells could now carry. Corrugated and ribbed furnaces still further increased the resistance of flues, and, working in the opposite direction, there has been brought out the water-tube boiler, which aims, by reduction of the diameter of the parts exposed to pressure, to give still higher pressure capacities to steam-generating vessels. So far, then, any attempts to define the upper limit of working pressure of the steam engine have met with no success, and this might have been foreseen had it been realised that such attempts were based merely upon casual disabilities of material and workmanship which could not be said to be insurmountable. It is, of course, very well known that even where higher pressures have been employed, or attained, the gain has often fallen far short of expectation, for higher pressures are necessarily accompanied by higher temperatures and by increased leakage loss and increased heat losses from radiation. Mechanical, as well as physical, reasons have almost compelled an increased number of cylinders where pressure has been raised, and the number of cylinders cannot be increased without an increase in friction.

Looking at the question from the side of first principles it becomes clear that if a limit is to be pronounced beyond which the steam engine cannot be subjected to increased pressures, such limit must first be sought in natural laws. Is there any point at which the natural physical laws appear to place a distinct barrier to any further advance? The introduction of tool steels during the last few years, which will work and remove tough materials at so great a rate that the tool itself becomes red hot, has demolished the once firmly-rooted opinion that iron, to use a generic name, could not work when red hot. Redness or incandescence has lost the meaning with which it was once so firmly associated in our minds, and it has become at least a subject for legitimate speculation whether a heat engine need be deemed unworkable because it has attained a temperature at which iron becomes visible in the dark.

But we cannot say that such a high temperature appears likely to occur with the steam engine, though it is certain that the working fluid in the internal combustion engine is considerably above a so-called red heat. Indeed, the exhaust temperature of some modern heat engines is greater than the initial temperature of any superheated steam yet employed, if not indeed greater than the maximum temperature at which steam ever will be employed if the findings of this article should prove ultimately to be correct.

The critical temperature of water and of steam is said to be 700° F. or thereabouts. That is to say, at 700° F. steam and water have the same specific density; they possess the same specific heat. The specific heat is supposed to be about 2 at that temperature. When heated above 700° F. the dissociation of steam into its elements hydrogen and oxygen is usually considered to commence. Unless this temperature of dissociation is raised by pressure, it would appear that the temperature of 700° F. or thereabouts must be the limiting temperature beyond which any further pressure or temperature will be inadmissible.

The pressure of steam rises with temperature at a rapidly increasing rate; thus, while only 67·2 lb. absolute at 300° F., it rises to 135 lb. at 350°, and subsequently to 247 lb. and 420·7 lb. for each subsequent 50° of temperature. Obviously, at 700° the pressure will be very high. Rankine's equation, if applicable to such high temperatures, and it agrees with experiment from 32° F. to 336° F., is:—

$$\log. p = A - \frac{B}{t} - \frac{C}{t^2},$$

where the symbols have the following meanings and values:—Log. p = common logarithm of the absolute pressure in pounds per square inch; $A = 6{\cdot}1007$; $\log.^{\circ} B = 3{\cdot}43642$; $\log.^{\circ} C = 5{\cdot}59873$, and t = absolute pressure. Then for the temperature in question—namely, 700° F.—the value of t will be $700 + 461 = 1{,}161°$ absolute.

Log. t and log. t^2 are respectively 3·064833 and 6·129666, whence the value log. p is found $= 6{\cdot}1007 - 2{\cdot}3528 - 0{\cdot}29448$, or $p = 2{,}840{\cdot}7$ lb. per sq. in. That is to say, the limit of pressure set by the physical properties of steam is about ten times or even twelve times the maximum absolute pressures that have hitherto been employed, though it is said that Perkins employed with fair success a pressure as high as 500 lb. per sq. in. many years ago. At such a high pressure as 2,800 lb. the steam would be an exceedingly unstable fluid, and would condense rapidly with slight provocation, and probably it would be found desirable to allow for superheating in order to prevent this.

If the added temperature of superheat were to be fixed at, say, 200° F., the absolute temperature of the saturated steam would be 961° F. The pressure corresponding to this temperature may be calculated from Rankine's formula, and found to be 674 lb. absolute. Now, this is a quite moderate pressure, and does not present those difficulties that are called up by the mention of so high a pressure as nearly

3,000 lb. per sq. in. It seems probable, therefore, that considering the great advantage that accrues to-day from the adoption of superheat, the practice will continue when pressures are higher, and in fixing on 200° F. as the added temperature above saturation temperature, the outside practice of the present day has merely been followed. It may then be concluded that, without exactly placing a limit at any point, it will be safe to defer speaking of any limit until steam pressures have attained 650 lb. by gauge, and a temperature saturated of about 500° F. with an additional superheat of 200°, making 700° in all, or 1,161° of absolute temperature.—B.

THE ELECTRICAL FROISSART CHRONICLES.

(With some apologies to Sir John, and more to "F. C. G.")

By IBID.

X.—Contra-Ktor.

In making close study and inquiry into the ways of those magicians, the Electriks, I have come upon many strange things; and, above all, a parchment whereon is a spell of very weighty and severe import. From the writing therein it is apparent that this is a charge laid upon a very powerful secondary spirit, or Djin, to perform certain marvels by reason of the allegiance he oweth to the primary, or magician, with sundry other inductions, or inducements.

In reading this parchment ye shall stand amazed not only at the knowledge of the Djins, but also at their power and readiness to perform extensive work. In it is set forth how, in a certain town, are to be made all things pertaining to the magic carriages of the Electriks, both as regards earth, air and water (especially water), and the great deeds that must be done in connection therewith. In these spells the Djin that performeth them is called by a hidden name, as Contra-Ktor; and the Electrik whom he serveth is called Ingenuus, besides other things. (Some there be that say that the real magician is Contra-Ktor, and that the Electrik called Ingenuus doth but serve him as middle-man, or fore-agent; so do all matters pertaining to these people appear to work in a closed circuit.)

The better to show the nature of these writings I will here transcribe a little:—"Whereas certain quantities, figures, marks, images and limits, are herein set forth, together with sundry plans and representations, numbers A to Z; he, Ingenuus, is not in any wise sure that the same are right and complete, and, therefore, he, Contra-Ktor, must assure and satisfy himself that these things exist and are in, on, or under, the earth; and if he depart from the quantities, figures, marks, images and limits, on account of what he shall find, and it turneth well, it is to the foresight of Ingenuus; but if otherwise, it is his own condemned stupidity and rashness; and he shall forthwith remove, take down, burn, sack and destroy, so much of the work as may be necessary in the judgement of Ingenuus, to remedy the same. Whereas, also, certain things be set down for his guidance and instruction in this volume; yet the same shall not be taken as necessarily meaning what is said, but the true intention thereof is to be taken; and if any doubt, trouble, darkness and mistrust, shall arise concerning such intent, it shall be submitted to the A.C.E. not then absent on his holidays; and his judgement shall be considered a semi-final."

Furthermore is much writing concerning the course or courses of the said carriages; and matters of this import: "As regarding the special crossing of Strasso Pericolo with via Lactea Street, Contra-Ktor shall submit drawings showing how he proposes to deal with it; and he, Ingenuus, of the kindliness of his nature, permitteth him to exhibit four several ways of effecting the same; wherefrom he, choosing one, will thereby intimate how he intended it to be from the first. At this crossing shall be placed a special frog, as in the drawing attached; and if the frog shall be unwilling, or unable, or refuse through illness to perform all that is required of it, Contra-Ktor shall so alter and strive with it that it doth so; but in no wise shall he attribute it to the design thereof; and, when it is perfect, it shall be labelled 'Ingenuus, his frog,' and maintained and kept in order for a space of years by Contra-Ktor."

From these words ye may see how great a discernment hath the Djin referred to, for that he can perceive the intent of another from his writings; and, moreover, can make something from the "drawing attached"; for it is not to be discerned by anything human how or wherein it resembleth a frog or any other reptile. In truth, however, the greatness of a man lieth not in the drawing that he maketh, but in the finding of one to understand it.

Towards the end of the parchment is a long chapter, on this wise: "Contra-Ktor shall provide, produce and supply, all matters pertaining to the trying of all those ways and works, to see that they are such as are desired; and the tests thereof shall be as follows: Where any engine shall bear the load of 50 horses, it shall have upon it the load of 75; and if any wall be 4 ft. high, it shall obstruct the view of a man 6 ft. high; so, also, the covers of all bars and metal shall be strained with four times the tension they will henceforth bear; so that peradventure a little extra may tear them."

"Finally, he, Contra-Ktor, shall maintain, uphold, protect and deliver those works from all acts of thieves, pirates, marauders, and the neighbours' children; from earthquake, tidal wave, fire, frost, and the borough surveyor; and shall render them up whole, safe, sound, and painted a lively colour (two coats), on the appointed day; failing in which he shall pay the sum of so much per day as shall, in the judgement of Ingenuus, finally and utterly teach him to do better things."

Doubtless ye will say, this is a legal document, and not intended, therefore, to have a meaning, or to be understood.

But thereby is the more evident the knowledge and magic of the Electriks, for they will offer to explain to you even these their own writings.

THE JUNIOR INSTITUTION OF ENGINEERS.

Summer Meeting in the Manchester District.

It was in 1892 that the Institution paid its previous visit to Manchester. The occasion is well remembered from the fact that, in addition to a number of engineering manufactories, the Ship Canal Works, which were then approaching completion, were seen, a description of them being given to the members by the engineer, Sir (then Mr.) E. Leader Williams personally. Since that year, many new and important works and places of technical interest have sprung up in the district, and others have been modernised, so that the programme recently carried through embraced visits to places which members had not had the opportunity of seeing before.

Southport was made the headquarters for the week, and proved entirely satisfactory, the arrangements at the Queen's Hotel where the party stayed contributing in no small degree to this result. Everyone commented on the attractive appearance of the town, and on the way it is maintained. Lord Street possesses quite a Continental air; this is especially noticeable in the evening, when the Municipal Gardens with their effective electrical illuminations and fountains are in full display, and the military band is performing.

The opening proceedings of the meeting took place in the Mayor's parlour of the Town Hall on Saturday, July 14th, when at 10.30 a.m., in the absence of the Mayor, the ex-Mayor, Mr. Councillor E. Trounson, gave a cordial and hospitable welcome on behalf of the Corporation of Southport. The electricity and gas estates were then inspected, the engineers, Mr. R. S. Downe and Mr. John Bond, respectively acting as cicerones. The gas and electricity works being contiguous, the immediate contrast in the character of the operations carried on with the identical object in each instance of the production and supply of light and power, was very marked.

Special mention should be made of the scientific methods which Mr. Bond is employing in his work. He gave some extremely interesting demonstrations with various types of pyrometers, thermo-electric, electrical resistance, optical, radiation thermo-electrical, and calorimetric, which he uses in investigations on the carbonisation of coal. Gas engineers generally appear to be recognising more and more the necessity of considering scientifically the various processes involved in the distillation of coal, instead of carrying them out in the old-fashioned way which obtained before the advent of electricity. It is a noteworthy circumstance, by the way, that electricity is being introduced increasingly as the motive power for the operation of gas works retort stoking and discharging machinery. Indeed, a knowledge of electrical science seems to be now demanded of the fully competent gas engineer, for

an important city in the Midlands, in setting forth the qualifications expected in a gas works superintendent required to fill a vacancy there, stipulate that "a thorough knowledge of electricity is essential."

The Southport electricity department in its last returns give the total number of consumers as 1,564, the output being equivalent to 102,115 8-C.P. lamps. The present capacity of the generating station is 4,250 I.H.P., but in anticipation of developing business, buildings have been erected to contain an aggregate of 15,000 I.H.P. The alternating single-phase supply for lighting and power consists of two 250-H.P. Musgrave engines driving 125-KW. iron-type Ferranti alternators; one 500-H.P. Musgrave engine driving a 300-KW. Ferranti iron-type alternator; one three-crank tandem compound 1,000-H.P. Musgrave engine driving a 600-KW. Ferranti copper type alternator; and one triple-expansion Belliss 1,000-H.P. engine, driving a 600-KW. copper type Ferranti alternator. There is also a direct current supply at 500 volts pressure, which is given to the Corporation tramways service and the Southport Tramways Co. This plant consists of three 350-H.P. Belliss central valve engines, driving 200-KW. Bruce Peebles compound-wound generators. A Dick, Kerr 200-KW. alternator is connected in tandem to one of these sets; and there is a 400-ampere Tudor battery.

On the following Monday two divisions were formed, one visiting the extensive works of the British Westinghouse Electric and Manufacturing Co. at Trafford Park; the other proceeding to the Manchester Municipal School of Technology. At the former the equipment of an electric railway on the single-phase system with overhead wire was shown. The car is fitted with four 100-H.P. motors, one air-cooled auto-transformer, two master controllers operating electric pneumatic unit switch worm controllers, &c. The current is taken from the overhead wire by a "pantograph" collector, the pressure on the trolley wire being 3,000 volts, and that applied to the motors 260 volts. At the School of Technology, of which Manchester is so justly proud, many features of electrical interest were to be seen, although the courses of study embrace in a most perfect manner the whole of the industries of the city and vicinity, textile subjects naturally receiving full attention. As indicating its comprehensive electrical equipment, it is only necessary to mention that in addition to the motors in the dynamo room, the plant available for testing includes steam-driven dynamos of different types, a turbo-generator, and over 100 motors in various parts of the building, aggregating 1,250 H.P.; the Electrical Engineering laboratory contains a 10-ton electric tramcar truck, fitted with two 25-H.P. motors and controllers, the truck being mounted on friction wheels for experimental work on problems relating to efficiency and acceleration; there are also typical single-phase motors; a photometer room; accumulator testing rooms; high tension room for voltages up to 100,000; standardising room; and an electro-chemical department.

After luncheon at the Town Hall by the kind invitation of the Lord Mayor, the afternoon was devoted to an inspection of Messrs. S. Schwabe's well-known calico-printing works at Rhodes, near Middleton, the ladies being shown over the Manchester Town Hall, the renowned Rylands Library, and one of the Corporation fire brigade stations.

Coaches were requisitioned on the following day for a drive through Rufford Park and Lathom Park on to Ormskirk. On returning, Scarisbrick Hall, a beautiful modern Gothic mansion, designed by Pugin, was visited, access to the interior being obtained through special permission which had been kindly given by its owner, the Marquis de Casteja.

Wednesday, a very full day, was spent at Ashton-under-Lyne, the first visit being to the works of the National Gas Engine Co. on the invitation of the President of the Institution, Mr. Dugald Clerk (who, unfortunately, could not meet the members, owing to his absence in America), and the other directors of the company. The managing director, Mr. Bickerton, had evidently spared no effort to render the occasion pleasant in every respect. Several hours were very profitably occupied in examining the various special machine tools running, and in receiving particulars of the system of manufacture introduced and developed at these well-managed and prosperous works, accuracy in the repetition of parts being, of course, a prominent characteristic. The visitors remarked on how fully all the departments were employed, and it was observed that building extensions were in active progress to meet the requirements of rapidly growing business. After luncheon, as the guests of the directors, Messrs. Heginbottom's weaving sheds were visited, and subsequently the Tudor and Atlas Cotton Spinning Mills.

On Thursday an excursion was made to Wigan. In the morning the Douglas Bank Collieries of the Rose Bridge and Douglas Bank Collieries Co. were visited. Most of the party descended the pit, and made their way to the working face, an electric coal-cutting machine being the attraction. In the afternoon they were shown over Messrs. Coop & Co.'s clothing factory, the very large number and variety of sewing machines seen at work serving to supply in some measure an explanation of the enormous output of the works at which that class of machinery is manufactured.

The excursion on Friday was to Liverpool by electric railway, the R.M.S. *Majestic* being seen in the morning with the engine room open to inspection, and St. George's Hall in the afternoon.

The Institution's summer dinner was held at the Queen's Hotel, Southport, in the evening, the chairman, Mr. Adam Hunter, presiding. In addition to civic representatives, a number of guests connected with the industries of the district were invited. In the course of the speeches which followed, appreciative reference was made to the great kindness and hospitality which the members had experienced everywhere during the progress of the meeting, which had been one of the most successful in the history of the society, the attendance of members from provincial towns being a particularly gratifying feature of it.

An additional visit to the new sewerage works of Southport was arranged at the last moment on the suggestion of the borough engineer, Mr. R. P. Hirst, which a number of the members availed themselves of on Saturday morning, under his guidance, the laying out and system of the undertaking being previously explained by him at the Town Hall with the aid of the working drawings.

TEST OF A 5,000-KW. CURTIS STEAM TURBINE.*

In March, 1906, a series of tests was made on one of the 5,000-KW. Curtis steam turbines which has been in commercial service for about one year in the Fisk Street station of the Commonwealth Electric Co., Chicago, Ill. The turbine set is one of four installed in this station.

The generating unit consists of a 5,000-KW. turbine, direct-connected to a six-pole three-phase, 5,000 KW. 9,000-volt 500 r.p.m. revolving field generator. All the tests, except those for speed, were made under regular commercial load conditions. On account of the change in frequency during the speed tests, the load was absorbed by a water resistance, composed of plates in the Chicago River.

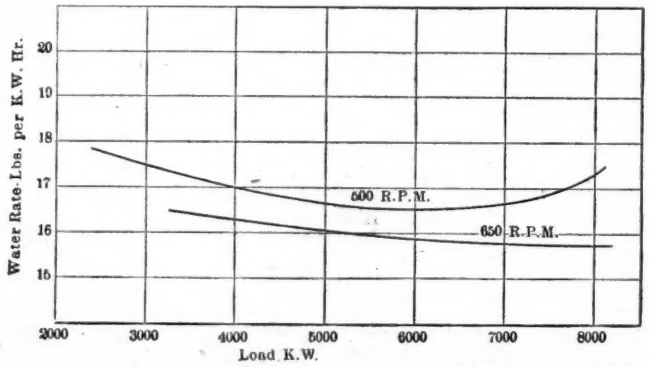


FIG. 1. TEST OF 5,000-KW. CURTIS TURBINE.

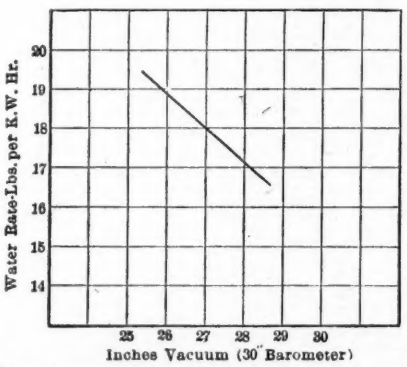


FIG. 2.

In the commercial tests the load dispatcher maintained a constant load on the turbine under test, by varying the tension of the auxiliary governor spring by means of a motor controlled from the switchboard. The steam pressure and superheat were kept as constant as possible.

The load was measured by special indicating wattmeters, connected to independent pressure and current transformers. All instruments were carefully calibrated at Schenectady, and the calibration was later verified in the laboratory of the Commonwealth Electric Co. As an additional precaution to ensure accuracy, the readings taken were checked by readings obtained from a duplicate set of instruments calibrated by the Electrical Testing Laboratories of New York. The load readings were recorded at intervals of two minutes.

All tests were made at about 150° F. superheat, the temperature being read by calibrated mercury thermometers. Temperatures and pressures were recorded every five minutes.

The amount of steam used was obtained by discharging the condensed steam into tanks, where it was weighed. After each

* *Electrical Review*, New York.

run the condenser was tested for leaks, which, as shown by the tables, were of small amount.

The detailed results of the test at 500 r.p.m. are shown in Table I. Table II gives the readings obtained at 650 r.p.m. To make the tests comparable, all results were reduced to 150° superheat, 1½ in. back pressure and 175 lb. (gauge) steam pressure. The

TABLE I.

Load. Kilowatts.	Steam pressure (gauge).	Superheat. Deg. F.	Total steam, lb. per hour.	Condenser leakage, lb. per hour.	Back pressure. Inches mercury.	Revs. per minute.	Steam consumption, lb. per KW.-hour. Actual.	Steam consumption, lb. per KW.-hour. Reduced.*	Notes.
3,340	171	151	56,690	1,070	0·89	500	16·66	17·29	Water rheostat.
5,940	169	180	98,370	950	1·72	„	16·40	15·55	Commercial.
2,920	172	158	50,930	1,050	1·08	„	17·18	17·61	„
4,860	179	180	81,550	1,700	1·55	„	16·50	16·81	Water rheostat.
7,525	175	147	130,200	820	2·09	„	17·19	16·91	„ „
4,950	180	171	80,370	220	1·48	„	16·13	16·55	Commercial.
0	178	150	3,520	220	1·40	„	—	—	Full voltage.

* Reduced to 150° F. superheat; 1½ in. back pressure; 175 lb. (gauge) steam pressure.

TABLE II.

Load. Kilowatts.	Steam pressure (gauge).	Superheat. Deg. F.	Total steam, lb. per hour.	Condenser leakage, lb. per hour.	Back pressure. Inches mercury.	Revs. per minute.	Steam consumption, lb. per KW.-hour. Actual.	Steam consumption, lb. per KW.-hour. Reduced.*	Notes.
3,530†	170	165	55,900	1,070	0·85	650	15·55	16·40	Water rheostat
5,140	180	179	81,930	1,700	1·50	640	15·67	16·03	„ „
8,090	177	141	131,160	820	2·03	640	16·11	15·80	„ „

* Reduced to 150° F. superheat; 1½ in. back pressure; 175 lb. (gauge) steam pressure; 650 r.p.m. † Average of two points.

reduced water rates are given in the ninth column of Tables I and II. These tables are summarised in Tables III and IV respectively, and from these are obtained the curves given in fig. 1, showing the performance of the turbine at 500 and 650 r.p.m.

TABLE III (Summary of Table I).

500 r.p.m.; 150° F. superheat; 1½ in. back pressure; 175 lb. steam pressure (gauge):—

KW.	Load.	Steam consumption.
2,500	½	17·74
3,750	¾	17·08
5,000	Full	16·62
6,250	1¼	16·52
7,500	1½	16·90

TABLE IV (Summary of Table II).

650 r.p.m.; 150° F. superheat; 1½ in. back pressure; 175 lb. steam pressure (gauge):—

KW.	Load.	Steam consumption.
3,750	¾	16·35
5,000	Full	16·07
6,250	1¼	15·88
7,500	1½	15·80

The tests were conducted under the supervision of the representatives of the purchaser, Sargent & Lundy, and those of the General Electric Co., Schenectady, N.Y.

A NEW TELEPHONE CABLE JOINT.

The *American Telephone Journal* recently described a practical mechanical cable joint invented by L. Hargis and C. E. Teush, of Evansville, Ind., who claim that it fulfils the requirement of being absolutely tight, and that its installation requires a minimum of time and labour and consequently of expense. The joint which is shown in fig. 1 consists of a lead sleeve closed at one end, the other end being sweated to an externally threaded brass collar which screws into an internally threaded brass cap. The brass cap has an extended rim and an inward offset for supporting a lead gasket. This gasket may be bored for the number and size of cables which it is desired to splice. Under the offset in the brass cap is a rubber washer. The act of screwing on the bottom of the sleeve binds the rubber washer against the lower side of the offset, and makes the joint perfect.

The method of installing the joint is substantially as follows, reference being made to numbered figures in the two group illustrations shown in figs. 2 and 3. The cables are bent at right angles to the messenger and the lead gasket put on. (No. 1.) The brass cap is then drawn up under the gasket and wedged or tied in place, the cable and gasket having been previously shaved so that the solder will adhere readily. The solder, at a little above wiping heat, is then poured in until the cup formed by the gasket resting on the offset is filled to desired height. Any roughness left by solder being poured unevenly is then smoothed with a blow-torch and

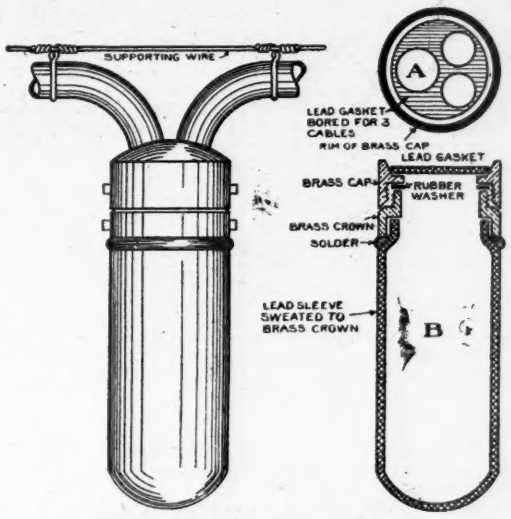


Fig. 1.—Mechanical Cable Joint.

wiping-cloth. (No. 2.) When the cables have thus been firmly fixed in the cap the sheathing is removed from them. This is done easily if before they are put through the gasket the cables have been marked around with a chipping knife so that a slight bend will cause the sheathing to break where it is marked. Exposed wires can then be boiled out (No. 3), spliced (No. 4), and laced (No. 5) in the usual manner. The joint is completed by screwing on the bottom of sleeve (No. 6).

The completed joint is said to have many advantages over a horizontal wiped joint. One of these is that it is accessible at all times for testing or changing a multiple. A "pair" can be picked out in much less time than is possible in a horizontal splice. This is due to the fact that one end of the splice is loose, and as a pair is tested it can be bent back out of the way.

A number of pairs may be left dead in a sleeve, and when these pairs are required it is simply necessary to bore a hole in the "leaded" top to fit the size of cable required to splice the dead pairs, then "lead" this cable in and connect it as was done with the original cables.

A splice can be boiled out without the use of a drip-pan, as the

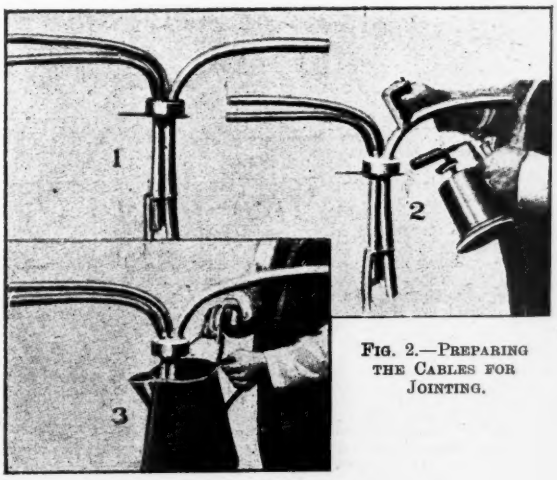


Fig. 2.—Preparing the Cables for Jointing.

boiling pot can be brought up under the splice so that the wires go directly into the paraffin. This method of boiling out entails absolutely no waste of paraffin. The saving this makes is shown by the common experience that every cable splicer's platform is soaked with the paraffin that is wasted by using a drip-pan.

No splice need ever be left open over-night. The top of the sleeve can be "leaded" in a few minutes. The sheathing can then be taken off, the wires laced to prevent damage to the insulation, and the bottom of the sleeve screwed on.

Every joint can be made a branch joint, and the greater the number of branches the smaller the amount of solder necessary to make the joint.

A sleeve can be used any number of times. When a cable is taken down the ends can be taken out of the sleeve, a new gasket put in, and the sleeve is as good as new. The soldered part of the joint is on the top, where it can readily be examined for pin-holes.

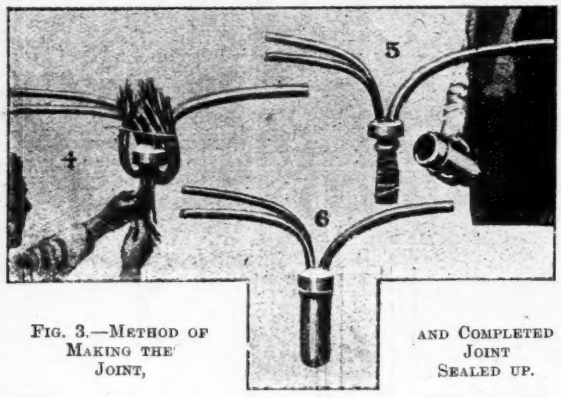


FIG. 3.—METHOD OF MAKING THE JOINT, AND COMPLETED JOINT SEALED UP.

It is peculiarly adapted to underground work, for the reason that its shape allows of the greatest economy of space in manholes. This style of joint lends itself to some very pretty work in making turns at a branch joint in aerial cable as shown in the plan view, fig. 4

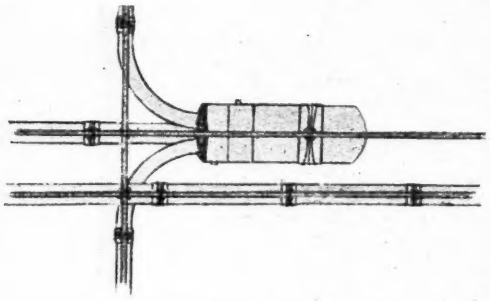


FIG. 4.—AERIAL BRANCH JOINT.

There are many forms of cable work to which this joint is adaptable. It has recently been put on the market by Messrs. W. N. Matthews & Bros., 219 No. Second Street, St. Louis, Mo.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

19,593. "Improvements in or relating to the control of the speed or working of motors or other machines from a distance or otherwise." SIEMENS BROS.' DYNAMO WORKS, LTD. (Siemens Schuckert-Werke, G.m.b.H., Germany.) September 3rd. (Complete.)

19,599. "Improvements in or relating to electric arc lamps." F. W. STEVENS and A. HELLER. (E. Cervenka, Austria.) September 3rd.

19,620. "Improvements in electric incandescent lamps." J. W. FORSTER. September 3rd. (Complete.)

19,623. "Improvements in electric batteries." W. J. L. SANDY and H. T. MIDDLETON. September 3rd.

19,626. "Improvements in or relating to electrically-driven ring spinning machines." AKTIENGESELLSCHAFT BROWN, BOVERI & CIE. (Date applied for under Patents Act, 1901, September 14th, 1905, being date of application in Switzerland.) September 3rd. (Complete.)

19,627. "Improvements in or relating to self-regulating dynamo-electric machines." MATHER & PLATT, LTD. (E. Rosenberg, Germany.) September 3rd.

19,689. "Improvements in apparatus for operating electrically-worked semaphore signals." SIEMENS BROS. & Co., LTD. (Siemens & Halske Akt.-Ges., Germany.) September 3rd. (Complete.)

19,666. "Improvements in and relating to joints for cane or like rods used in drain cleaning, chimney sweeping, electric cable wire-drawing and kindred purposes." H. BRASSINGTON. September 4th. (Complete.)

19,690. "Improvements in electrical terminal fittings for effecting junctions between main and branch cables in conduit junction boxes, without the aid of soldered joints." H. HIRST and C. E. GUNNER. September 4th.

19,701. "Improvements in electrical indicating clocks." E. DUBS. (Date applied for under Patents Act, 1901, September 5th, being date of application in Switzerland.) September 4th. (Complete.)

19,704. "Improvements in brushes for dynamo-electric machines." THE MORGAN CRUCIBLE CO., LTD., and C. W. SPEIRS. September 4th.

19,705. "The manufacture of a composition or compound for use in the production of commutator brushes and for other purposes." THE MORGAN CRUCIBLE CO., LTD., and C. D. MCCOURT. September 4th.

19,709. "Method of and means for sealing electric conductors into or through glass or like vitreous material." C. O. BASTIAN and G. CALBERT. September 4th.

19,717. "Improvements in alternating current electric machines." FELTEN AND GUILLEAUME-LAHMEYER WERKE AKT.-GES. (Date applied for under Patents Act, 1901, September 4th, 1905, being date of application in Germany.) September 4th. (Complete.)

19,731. "Improvements in automatic switches for telephone systems." P. HILDEBRAND and A. C. DIESEL. (Date applied for under Patents Act, 1901, September 6th, 1905, being date of application in Germany.) September 4th. (Complete.)

19,741. "Improvements in controlling devices for electrically-driven stereo-plate boring machines." S. LORD. September 5th.

19,756. "Electro-magnetic variable gear, for motor-cars, motor-cycles and the like." L. MITCHELL. September 5th.

19,793. "Improvements in and relating to electric measuring instruments." THE BRITISH THOMSON-HOUSTON CO., LTD. (The General Electric Co., United States.) September 5th.

19,805. "Improvements relating to receivers for wireless telegraphy." A. ARTOM. September 5th. (Complete.)

19,861. "Cable conduit for electric mains." V. P. VON PINDTERSHOFFEN. September 6th. (Complete.)

19,865. "Improvements in and relating to electric heating devices." THE BRITISH THOMSON-HOUSTON CO., LTD. (The General Electric Co., United States.) September 6th.

19,874. "Improvements in switch-throwing or operating devices." H. O. MARQUIS. (Date applied for under Patents Act, 1901, November 21st, 1905, being date of application in United States.) September 6th. (Complete.)

19,878. "Improvements in and relating to apparatus for use in signalling by electro-magnetic waves." THE DE FOREST WIRELESS TELEGRAPH SYNDICATE, LTD. (Lee de Forest, United States.) September 6th. (Complete.)

19,881. "Improvements in and relating to wireless telegraph systems." THE DE FOREST WIRELESS TELEGRAPH SYNDICATE, LTD. (Lee de Forest, United States.) September 6th. (Complete.)

19,916. "Improvements in electric switches." H. G. LONGFORD. September 7th.

19,945. "Improvements relating to electric storage batteries." J. BOYLE and H. HARTLEY. September 7th.

19,951. "Improvements in primary batteries." H. SEFTON-JONES. (The Decker Electrical Manufacturing Co., U.S.) September 7th. (Complete.)

19,963. "Improvements in electrically-operated fire alarm installations." A. G. BLOXAM. (Siemens & Halske Akt.-Ges., Germany.) September 7th. (Complete.)

19,980. "Electro-magnetic safety lock, applicable to railway carriage doors or other doors." T. ROWBOTHAM, W. S. GOSPEL and F. ARCHER. September 8th.

20,028. "Improvements in electric arc lamps." H. W. HEADLAND and F. PLUTTE. September 8th.

20,041. "Improved apparatus for winding closed iron cores for transformers choking coils and the like." SIEMENS & HALSKE AKT.-GES. (Date applied for under Patents Act, 1901, September 12th, 1905, being date of application in Germany.) September 8th. (Complete.)

20,043. "Automatic electric switch." R. M. NEWBOLD. September 8th. (Complete.)

20,050. "Improvements in and relating to the regulation of the voltage of alternating electric current distribution systems." ALLGEMEINE ELEKTRICITATS GESELLSCHAFT. (Date applied for under Patents Act, 1901, September 9th, 1905, being date of application in Germany.) September 8th. (Complete.)

20,054. "Method of producing metallic salts by electrolysis and employing the same for useful and curative purposes." J. W. MACKENZIE. (L. Bolle and Co., G.m.b.H., Germany.) September 8th. (Complete.)

20,056. "Apparatus for electrically measuring the height or the pressure of fluids at a distance." D. PERRET. (Date applied for under Patents Act, 1901, September 9th, 1905, being date of application in Switzerland.) September 8th. (Complete.)

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1905.

ELECTRIC SWITCHES OR RELAYS. A. Vera and L. G. Vera. 10,298. (Date applied for under International Convention, May 17th, 1904.) May 16th.

MEANS FOR ELECTRICALLY OPERATING AND LOCKING RAILWAY POINTS, SIGNALS, AND THE LIKE. L. Kottmair and R. Zwack. 12,953. June 22nd.

MEANS FOR ENSURING THE CONTINUITY OF MOVEMENTS DERIVED FROM ELECTRIC ENERGY. A. B. Webber and The Stannard Time Co. 12,999. June 23rd.

MANUFACTURE OF FILAMENTS FOR INCANDESCING ELECTRIC LAMPS. J. R. Crawford. 14,898. July 19th.

ARC LAMPS. E. R. Grote and M. V. Ely. 17,106. August 23rd.

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ELECTRIC ROAD MOTOR VEHICLES. A. Vedrine and Count Raoul de Quélen. (Date applied for under International Convention, October 26th, 1904.) 21,659. October 24th.

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CONTACT APPARATUS FOR ELECTRICAL IGNITERS. C. A. Day. (Fabrik Elektrischer Zunder.) 22,198. October 31st.

MOUTH-PIECES FOR TELEPHONES. P. J. Mantle. 25,464. December 7th.

ELECTRICAL SWITCHES. W. R. Comings. 27,188. December 29th.

1906.

POLE FOR SUPPORTING ELECTRICITY TRANSMISSION LINES, AND THE LIKE. M. Kastler. (Date applied for under International Convention, April 1st, 1905.) 1,961. January 25th.

ELECTRIC APPARATUS FOR RAPIDLY WARMING OR HEATING AND DISTRIBUTING LIQUIDS. R. C. Gardner, A. C. Bremant, France. 2,811. February 5th.

ADJUSTERS FOR ELECTRIC LIGHT CORDS. J. T. Hatherly and T. H. Hatherly. 5,415. February 12th.